WORLD PETROLEUM

NOVEMBER, 1961

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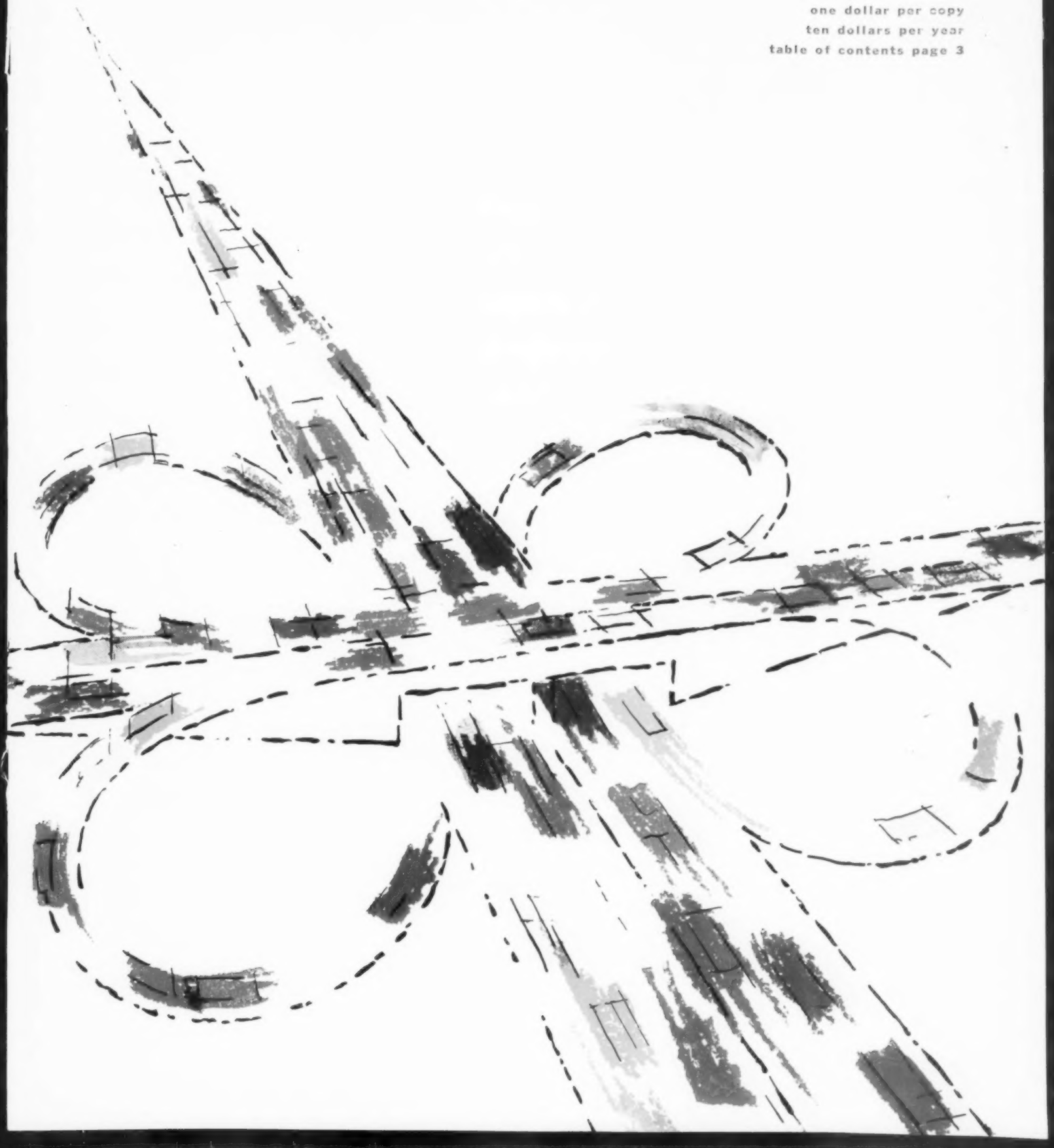

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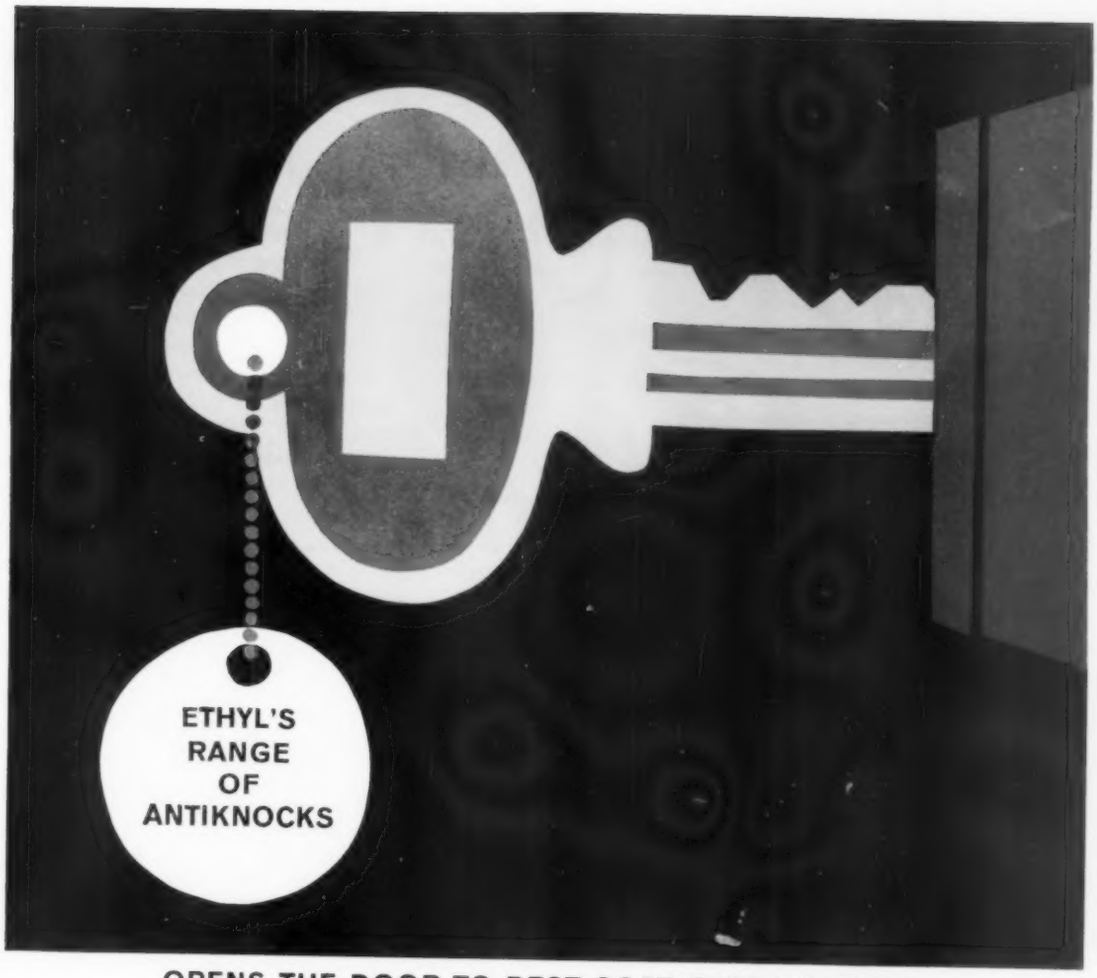

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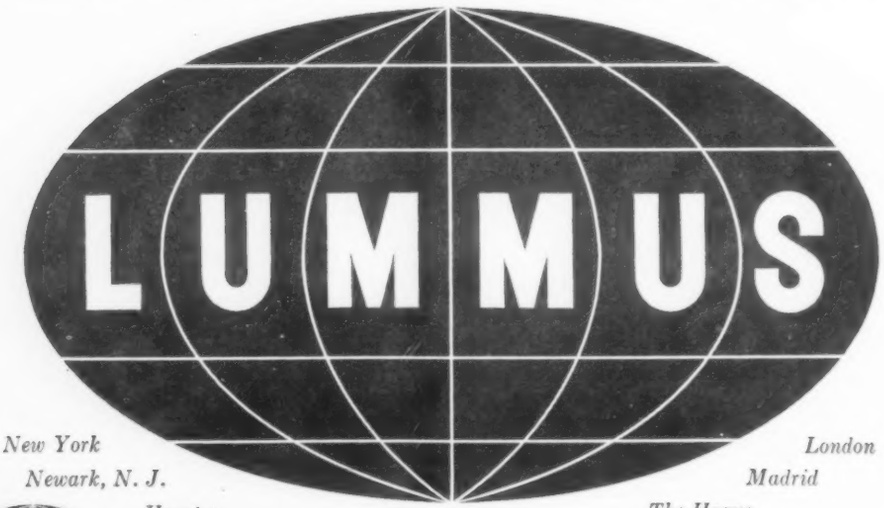

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World Petroleum

THE MANAGEMENT PUBLICATION OF THE INTERNATIONAL PETROLEUM INDUSTRY

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Washington Pipeline

by Joseph B. Huttlinger

Industry Men in Government

It's no sin to be an oil man in the eyes of President Kennedy. Unlike some of his predecessors at the White House, he has been turning to the ranks of oil and gas to fill some of the top government posts. All signs are that he will continue to do this in the future, for he is highly pleased with the work of the few oil men he has named to top jobs. They include:

John M. Kelly, an independent producer of Roswell, N. M., assistant secretary of the Interior in charge of oil and other matters. Kelly is making such a record, in fact, that he will be considered for Secretary in the event Stewart L. Udall, the present Secretary steps out. Udall has been urged to run for the Senate from Arizona.

Lawrence J. O'Connor of Houston, Texas, a member of the Federal Power Commission, which regulates the natural gas and electric power industries. O'Connor began with the Eisenhower administration, in the Oil Import Administration.

Jerome J. O'Brien of Texas, past president of the Texas Independent Producers and Royalty Owners Association, who is Director of the Office of Oil and Gas. This is the agency that works up policies for oil and gas, and speaks for oil within the government.

In the light of the record of these men so far, Senators such as William Proxmire, D., Wisc., who claim a background in oil is a disqualification for federal service, are definitely in the minority.

FPC again up to Five Men

The Federal Power Commission, which has been at less than full strength almost constantly since March, 1960, now is up to its five-man quota again. This point was reached Sept. 29 when Charles R. Ross, former chairman of the Vermont Public Service Commission, was sworn into office as a member.

President Kennedy's earlier nominees—Joseph C. Swidler of Tennessee, as chairman; Howard Morgan of Oregon and Lawrence J. O'Connor of Texas as members—have already been sworn into office.

The new commission is going along with the effort to set prices of natural gas sold by producers on the basis of the area of production. This was started by an Eisenhower commission, but now carries the approval of the Kennedy body. Chairman Swidler's warning to producers that if they have area prices they must stick to them and not try to justify higher prices on the basis of higher costs sounded new, but actually was a repeat of views of former chairman Jerome Kuykendall. Swidler said it more clearly and more loudly, that's all.

A shift appeared when the Kennedy members of the commission voted to refuse permission for Tennessee Gas Transmission Co. to substitute compressor stations at a cost of more than $6 million instead of 157 miles of pipe line at a cost of about $26 million. This shift was underlined as Kuykendall voted with the minority to go along with Tennessee's request.

But about a month later, the Kennedy members of the commission changed their minds and swung over to the Kuykendall view.

Swidler promises big changes ahead, however. For instance, he promises more speed and insists this can be done if the FPC will lay out broad policy guidance so that examiners and others at the FPC can clear rules. Then similar cases could fall into line.

And Swidler continues to study FPC action to exempt thousands of smaller producers from any rate regulation at all. He feels that if the big producers are controlled, the smaller ones in effect will be controlled as well.

Next Congress Will Study Imports

The program to limit imports of crude oil and of oil products will be attacked and defended next year when Congress is due to take its first full-scale look at the program since it was authorized in 1958. This will come when the Congress considers another extension of the reciprocal trade agreements act which expires next year unless extended.

Odds are that the agreements program which carries the authority for the oil import curbs, will be extended aagin, if only because it has been continued ever since it started in the 1930's. But it is only factual to report that the trade program today is under the heaviest attack since it began, partly because of high tariff walls against USA goods in many parts of the world and partly due to the recent and stubborn recession in this country.

And, if the trade program were ended, it would need a separate legislative act by Congress to continue the oil import curbs. Whether this could be achieved is open to doubt.

In addition to this, a House Small Business subcommittee, under Rep. Tom Steed, D., Okla., as chairman, soon is to open hearings into the workings of the import curbs on oil. As a first step, he sent out a detailed questionnaire to USA oil producers, refiners and importers for facts as to their operations under the import program.

Since Steed's study is the first by any committee of Congress since the oil import program began, it is attracting more than a little interest both among government officials and within the industry. Whatever recommendations Steed makes—if they are supported by facts—will receive attention.

But Other Matters will also Be Discussed

A number of other matters affecting oil and gas are also due for attention of Congress when the second session opens next January. All bills started through the legislative mill in the first session, which ended Sept. 26, pick up from where they left off at adjournment.

Thus, a natural gas bill is still before Congress, and the House Commerce committee under Rep. Oren Harris, D., Texas, may hold hearings. Only the most optimistic expect any gas bill to help producers to pass next year.

The income tax depletion allowance is due for attention as Secretary of the Treasury Douglas Dillon has indicated he'll give the administration's views next spring.

There are many signs that the administration, if it mentions the depletion provision, will call for it to be shaved down, perhaps from 27.5% to 22.5%. Congress may have different ideas, but change is always possible and any change that comes will cut the provision.

In addition, a half dozen antitrust bills, most of them opposed by major oil companies, are in the legislative mill, amid signs that some, at least, may pass. Among the likely candidates for passage is a bill to allow the Federal Trade Commission to issue temporary injunctions when it files a complaint against a business firm.

Other measures would bar "below"-cost sales; insist upon functional discounts for wholesalers and retailers; curb price discrimination; seek to curb dual distribution by oil companies and other businesses; and forbid tire manufacturers to operate at retail. A measure to forbid oil refiners from operating at retail may be put in again, although the administration is opposed to divorcement.

Congress has shown sympathy with a measure to let the self-employed, such as service station operators, have an income tax break on funds they set aside for their retirement; but Treasury is opposed. The same is true of a measure to allow service station operators a refund of shrinkage or evaporation.

Past Session Handled Many Oil Matters

With these important measures ahead, it would seem that Congress did little about oil and gas in the first session. But this is hardly true.

In a nine-month session, the longest since 1951, Congress voted to continue the federal gasoline tax at 4c/gal until 1972; launched a national fuels study at the request of coal; and enacted a minimum wage bill that raised the national minimum and brought thousands more employers under the act.

The fuels policy study is seen as the most important of these measures, but it also is the one which raises the biggest question marks. While no immediate action is expected from the study, its recommendations could become important in influencing the course of legislation by Congress and of policy as government agencies. Coal wants, basically, two things: curbs on residual oil imports and curbs on sales of natural gas for industrial uses.

The spade work for the fuels study is being done by a staff headed by Samuel Lasky, an Interior Department official. Helping him are Herbert J. Bickel of Texas Eastern Transmission Corp., John M. Ryan of Humble Oil and Refining Co.; and Dr. C. J. Potter, president of Rochester and Pittsburgh Coal Co. of Indiana, Penna. Assistant to Potter is Joseph J. Quinn, traffic manager of Rochester and Pittsburgh.

Government by Questionnaire?

At least three questionnaires have reached members of the oil and gas industries during recent months, each of them asking many detailed questions.

One came from Rep. Tom Steed, D., Okla., chairman of a House Small Business subcommittee, investigating the program to limit imports of crude oil and products.

A second came from Rep. James Roosevelt, D., Calif., chairman of another House Small Business subcommittee, studying the plight of the service station operator under a shortage of capital for operating, for expansion or for purchase of the station he operates.

The third, the largest of all, went to some 350 gas producers in the Permian Basin of West Texas and New Mexico, seeking details of their costs and volumes of gas reserves and production. This questionnaire is designed to obtain basic facts for the Federal Power Commission to use in setting prices of gas by specific producing areas. In fact, the FTC sent out a second, more detailed questionnaire, to some 80 of the larger producers in the area asking even more facts about costs, revenues and reserves.

Urges Broader Role for FTC

A. Everette MacIntyre, the newest member of the Federal Trade Commission, is urging the commission to take a far broader and larger role in antitrust law enforcement. Now, he says, the commission proceeds on a case by case basis, against one company or another. As a result, he says, the backlog at the FTC grows larger. He urges the commission to proceed industry, under its power to outlaw "unfair trade practices."

In essence, he wants the commission to make economic and legal studies of the facts; specify practices which are illegal in an industry; and then move against anyone who engages in the forbidden practices. It would be a new departure for the FTC, and could mean major changes for industries, such as oil.

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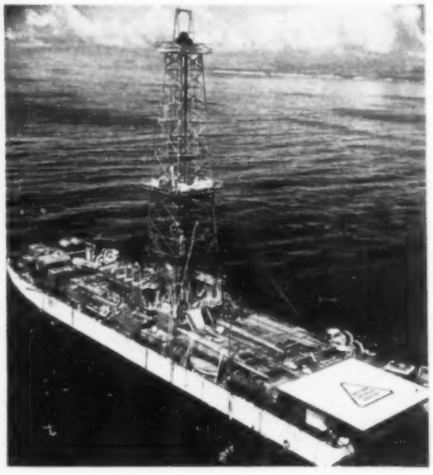

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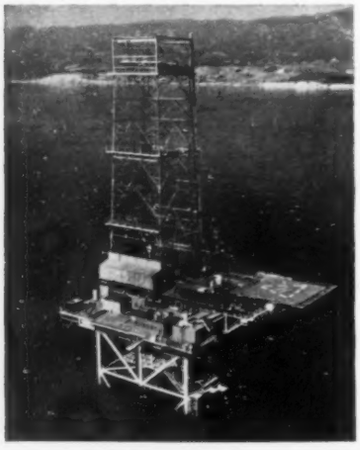

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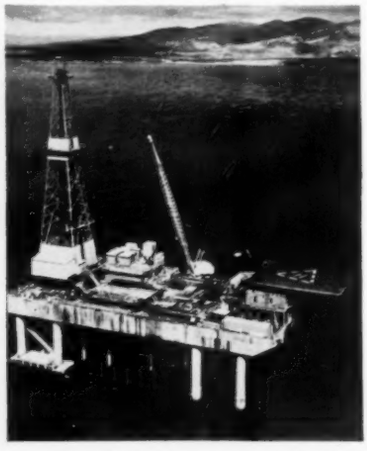

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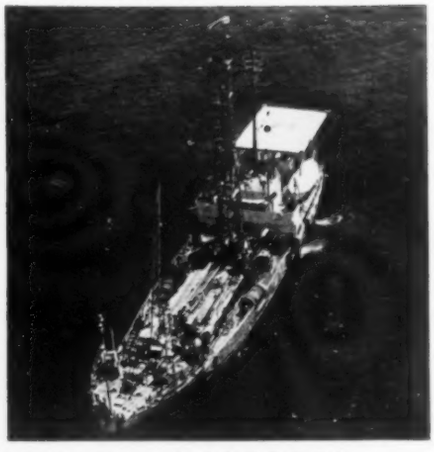

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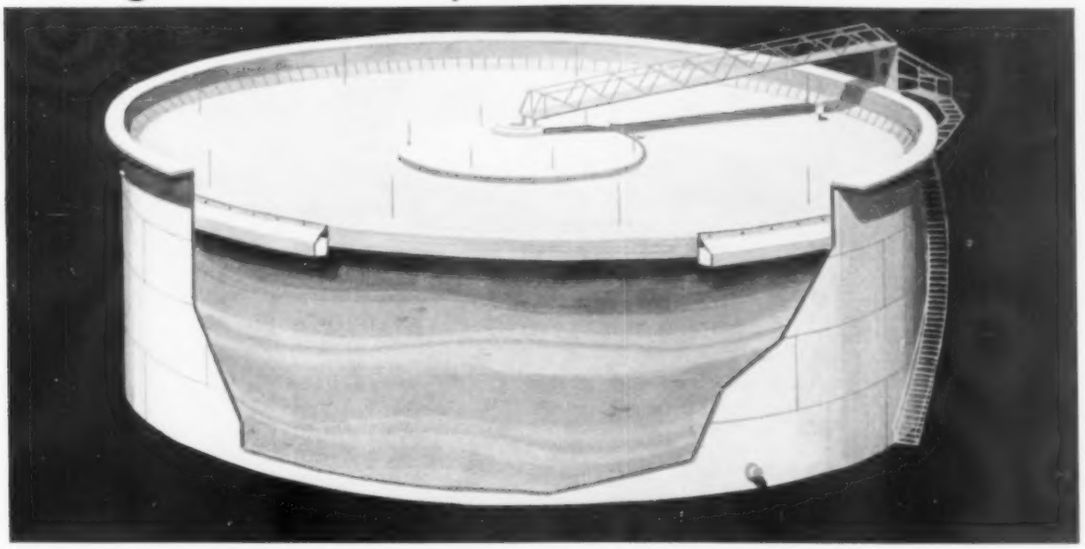

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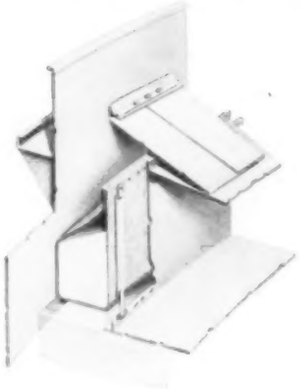

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Oil Consumption Slows Up in Half-Year

Deliveries of petroleum products into UK inland consumption (excluding bunkers for foreign-going ships) totalled 23,171,887 long tons in the first six months of 1961, an increase of 1,946,775 tons (9.2%) over the same period of last year. In 1960 the rise over the first half of 1959 was far higher at 3,363, 508 tons (18.8%). Returns independently collated on behalf of the UK Petroleum Industry Advisory Committee can be summarized thus (figures are in 1,000 long tons):

DELIVERIES INTO UK CONSUMPTION
January to June

	1961	1960
Aviation fuels	1,007	805
Motor spirit*	3,928	3,637
Industrial† and white spirits	185	195
Kerosine	806	879
Diesel road fuel	1,386	1,252
Gas/diesel/oils	2,010	1,768
Fuel oil‡	11,449	10,498
Chemical feedstock	795	765
Light distillate feedstock	252	189
Refinery gases and propane/butane	231	191
Other sorts	1,123	1,048
Total	23,172	21,225

Notes: * Includes motor benzole. † Includes industrial benzole. ‡ Includes refinery consumption: 1961—1,731; 1960—1,637.

Commenting on the latest return, Petroleum Information Bureau asserts that the rate of increase for black oils has moderated somewhat following the imposition of the 2d/gal (about £2/ton) tax in April.

Fuel oil consumption (excluding refinery use) was 9.7% up at 9,717,578 tons, and gas/diesel oils showed an advance of 13.7%. Total black oil consumption was 13,458,624 tons, an increase of 9.7%, and the group now represents 58% of total deliveries. Another interesting point is the reflection in the aviation fuels figure of the growing demands of large jet aircraft.

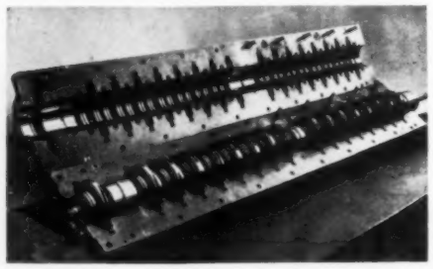
The current slowing up in the rate of rise of fuel oil deliveries (excluding refinery use) is demonstrated by the fact that the January/June 1960 total showed a rise of 29.0% over the 1959, while the latter was even higher, at 36.5% over the 1958 period. There are also indications of the first slowing up in deliveries of chemical feedstock.

Equipment Orders in the Six Months

The value of orders for materials and equipment placed in the UK by oil companies totalled £52.3 million in the first half of this year, according to statistics compiled by the Oil Companies Materials Association and issued by the Council of British Manufacturers of Petroleum Equipment. This compares with £60.7 and £56.7 million in the same periods of 1960 and 1959, respectively. The peak for this period is £66.0 million in 1957. These totals exclude tankers and orders received from oil companies and state oil organizations not based in the UK.

The two largest categories—(1) bulk chemicals, at £13.4 million, and (2) tubulars, pipe fittings and valves, at £4.8 million—each show a decline in orders of £1.0 million compared with the first half of 1960.

There is a welcome revival in orders for specialized equipment for refineries (excluding pumps and valves), for the half-year total of £4.5 million compares with £2.8 million in the 1960 period. The total for specialized equipment for drilling and production is down, however, to £3.0 from £4.7 million.



Special Volute Pumps for Fawley

Since manufacture of double volute centrifugal pumps by David Brown Industries Ltd., of Huddersfield (Yorkshire), was initiated mid-1960 under an agreement with The Bingham Pump Co., Portland (Oregon), the David Brown Bingham range has been extended from standard horizontal single-stage process pumps to include special units for chemical plant in oil refineries.

In the first instance these units have been made for Esso Petroleum Co.'s second chemical plant at its Fawley refinery to orders placed by Foster Wheeler Ltd. Eight-stage vertical pumps have been supplied for pumping liquid ethylene at minus 152 F. These have 70 gpm capacity—at 2,100 ft head and this can be extended to 140 gpm at 1,250 ft head. Operating speed is 5,800 rpm with drive from a directly-coupled vertical steam turbine.

Sixteen-stage pumps with 7-ft long inner casings are required for another section of this plant. These will handle liquid hydrocarbons at minus 130 F and each be drawn at 3,000 rpm by a vertical induction motor and will handle 20 gpm against 1,325 ft differential head.

These David Brown Bingham pumps are claimed to be unique in that the double volute case consists of two similar volutes, each spanning half the impeller circumference. Thus pump case hydraulic pressure is balanced at all diametrically opposed points around the periphery of the impeller throughout the pumps operating range, and this is so regardless of head, capacity or speed.

ICI To Produce a New Yarn

Imperial Chemical Industries Ltd., has started producing a new high-tenacity polypropylene yarn —termed "Ulstron"—on a pilot plant at Wilton. The first full-scale plant, with 5 million lb/yr capacity, will be in operation at Wilton by the year-end and extensions will be built as required at Kilroot in Northern Ireland. Supplies will be on the market early 1962 and the first commercial uses will be for fishnetting, twines and ropes, representing the results of development work since the rights for UK manufacture and sales of polypropylene fibers were acquired from Montecatini in August 1960. Polypropylene is the only man-made fiber available to the fishing industry and, by special production techniques, ICI has succeeded in making "Ulstron" stronger than any other polypropylene yarns currently being produced elsewhere in the world.

Distillers' Expansion Program

An indication of the high level of plant construction by The Distillers Co. Ltd., is the fact that, as of March 31, outstanding group commitments for capital expenditure totalled £6.6 million, against £414 million the year before.

Among the highlights of the current expansion program is the establishment of a works center at Baglan Bay, South Wales. This new development, states the chairman—Sir Graham Hayman—in his recent review, is a progressive one. It will afford the company adequate facilities in the years ahead for increasing its scale and range of petroleum chemicals. A large cracker is being installed as a base for long-term plans, which initially provide for plants to produce and monomeric styrene, to supplement production at Grangemouth.

The associated company, Grange Chemicals Ltd., is constructing a 15,000 tons/year phthalic anhydride plant at Hull which will be the first in the UK to use orthoxylene, a product of the petroleum industry, as raw material.

British Hydrocarbon Chemicals Ltd. (50% owned) has recently brought into operation a new plant to produce ethylene dichloride, which material will be used by Distillers' plastics division in an improved method for manufacturing polyvinyl chloride.

"Baby" Gas Turbine for Firefighting

A unique gas turbine firefighting system—first of its type in the world—has recently been installed by the National Trust at Waddesdon Manor, near Aylesburry, one of the famous stately homes of Britain and containing one of the country's finest art collections. It has already speedily extinguished a fire which might have spread and caused irreparable damage.

This system, which can be started up by one man, is based on a 50 hp Perkins Mars "baby" gas turbine driven water pump—one of the smallest and lightest gas turbines made in the world. It measures 24 by 22 by 17 inches and weighs only 98 lb. Thus it can be carried by two men and, at rated power, it delivers 500 gpm at 100 psig discharge pressure—as much as many fire engines—through a water main with seven hydrant points.

In the engine, the 40,000 rpm of the turbine rotor is reduced by a single spiral bevel gear and pinions to 4,400 rpm output shaft speed The pump is of single-stage centrifugal design, having the impeller fitted directly on the gearbox output shaft, with a speed of 4,428 rpm. It has no bearings or gearing, and only three principal parts—impeller, case and suction manifold.

Appointments

G. M. DAVIES, who has had extensive experience in the oil industry, has joined Middle East Oilfield Supplies Co. Ltd., and is in charge of its Beirut office. He was with Oil Well Supply Co. in the US and Mexico, and has worked with major oil companies and a supply house in Venezuela.

P. J. MARCH, director of Shell Chemical Co. and general manager of its industrial chemicals division, has been made a director of Styrene Co-Polymers Ltd. He succeeds **N. A. ILIFF**, managing direrctor of Shell Chemical, who has resigned.

(Continued on page 12)

HORTONCLAD® Again Combats Corrosion for Less Money

Hortonclad is the registered trade mark for vacuum clad plates developed by Chicago Bridge & Iron Company.

CB-6124

To combat corrosion, with economy, CB&I's Hortonclad was selected for this 17-foot diameter reactor for a petroleum catalytic reforming unit. It is one of five fabricated for Shell Oil Company's Wood River, Ill. refinery supplied through Arthur G. McKee Company.

Hortonclad, produced by a special CB&I process, provides the same benefits as solid corrosion-resistant material at substantially less cost. The 3.65" thick plate used in this reactor, for example, consists of ¼" Type 405 stainless clad to carbon steel.

A wide selection of cladding and backing materials, fully meeting or exceeding ASME and ASTM specifications, is available.

Look into the cost advantages of equipment fabricated of Hortonclad for your next job. Write for Bulletin G-43. Chicago Bridge & Iron Company, 332 S. Michigan Ave., Chicago 4, Illinois. Offices and subsidiaries throughout the world.

Only CB&I Vacuum Bonds Clad Plates

Hortonclad, available only in CB&I-fabricated vessels and other clad structures, is a composite metal having an integral and continuous bond produced by a high vacuum bonding process.

- **Thickness remains unchanged.**
- **Harmful gases are excluded.**
- **Clean, strong uniform bond is produced.**
- **High quality finish is maintained.**

This is why Hortonclad is superior to ordinary cladded metals for corrosion resistance and design economy.

An exclusive CB&I development

London Letter

(Continued from page 10)

VINCENT N. HURD, has been appointed manager of the newly formed petrochemicals department of Gulf Eastern Co. in London.

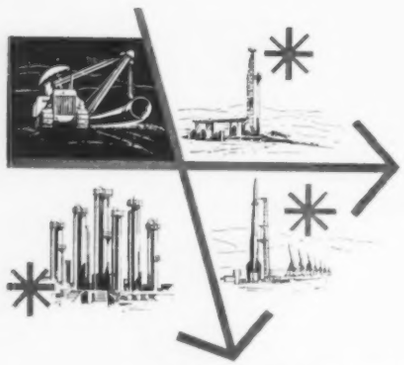
K. C. McCarthy

W. F. Phillips

Castrol Ltd. announces that when the four new assistant managing directors take office January 1, next they will relinquish their present executive appointments and will be succeeded by: **K. C. McCARTHY**—general manager, Castrol division; **W. F. PHILLIPS** and **R. LAYET** joint general managers, overseas division; **E. E. HUGHES,** sales manager, Castrol division; and **K. E. SHUREY,** group publicity manager.

R. Layet

E. E. Hughes



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Burden provides complete pipeline system construction anywhere in the world . . .

* DRILLING / REFINERY, CHEMICAL PLANT AND MISSILE BASE CONSTRUCTION THROUGH AFFILIATED COMPANIES

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PIPELINE CONSTRUCTION AND RECONDITIONING

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CABLE: ORB

K. E. Shurey

T. H. R. Perkins

The Perkins group announces the following new appointments: **T. H. R. PERKINS** has been made assistant managing director and continues as marketing director; **D. F. W. McNAIR** becomes deputy director of marketing; and **J. M. COLLINS** a director of Perkins Engines Ltd., is made general manager of the group's sales division.

D. F. W. McNair

J. M. Collins

SYDNEY TINDALE, general manager of marketing for National Benzole Co. since January 1960, has been made a director and will continue to be responsible for sales and physical operations.

H. D. Walker

S. Tindale

HECTOR D. WALKER has retired from the board of Constructors John Brown Ltd., but will continue to be associated with the company as a consultant and as a director of the subsidiaries Automatic Engineering Ltd. and Corrosion & Welding Engineering Ltd.

Frederic R. Harris Inc.

Consulting Engineers

144 East 44th Street

New York 17, N. Y.

Engineering for the Petroleum Industry

Construction Management

Studies, Design, Operation

Frederic R. Harris (Holland) N.V.

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The Hague, Netherlands

E. J. Robinson

R. F. N. Otway

E. J. ROBINSON has been made a director of The Head Wrightson Export Co. Ltd., and **R. F. N. OTWAY** has joined the company from The Morgan Crucible Co. as manager—Europe.

British Equipment News

Hawker Siddeley Engineering has been formed by Hawker Siddeley Industries Ltd., as a new division to undertake the design and construction of comprehensive engineering schemes. By drawing on the extensive facilities of the group's many factories in the UK and overseas, self-contained "turnkey" contracts for major undertakings can be accepted on what is termed "an entirely new concept—automation with muscles. By integrating the latest aviation techniques with our heavy engineering skills, we can offer a new kind of industrial packaged deal, centrally planned and controlled by a single contractor."

Each of Shell Tankers' three latest vessels—the "Serenia," "Solen" and the "Sepia," all of 65,000 dwt—will be protected by a combination of fixed and portable fire extinguishing equipment supplied by *The Pyrene Co. Ltd.* A pre-mix foam installation for pump and boiler room includes a 1,800-gal. tank and three 80-lb. carbon dioxide cylinders. On deck four mechanical foam monitors are located on the fore and after gangways.

A £40,000 contract for special oilfield trucks has recently been added to the £230,000 worth of orders which *Leyland Motors Ltd.* has secured from Romania this year.

INTRODUCING THE NEW

DRYDEN-EAST HOTEL

39th St., East of Lexington Ave.

NEW YORK

Salon-size rooms • Terraces • New appointments, newly decorated • New 21" color TV • FM radio • New controlled air conditioning • New extension phones in bathroom • New private cocktail bar • Choice East Side, midtown area • A new concept of service. Prompt, pleasant, unobtrusive.

Single $15 to $22 Suites to $60
Special rates by the month or lease

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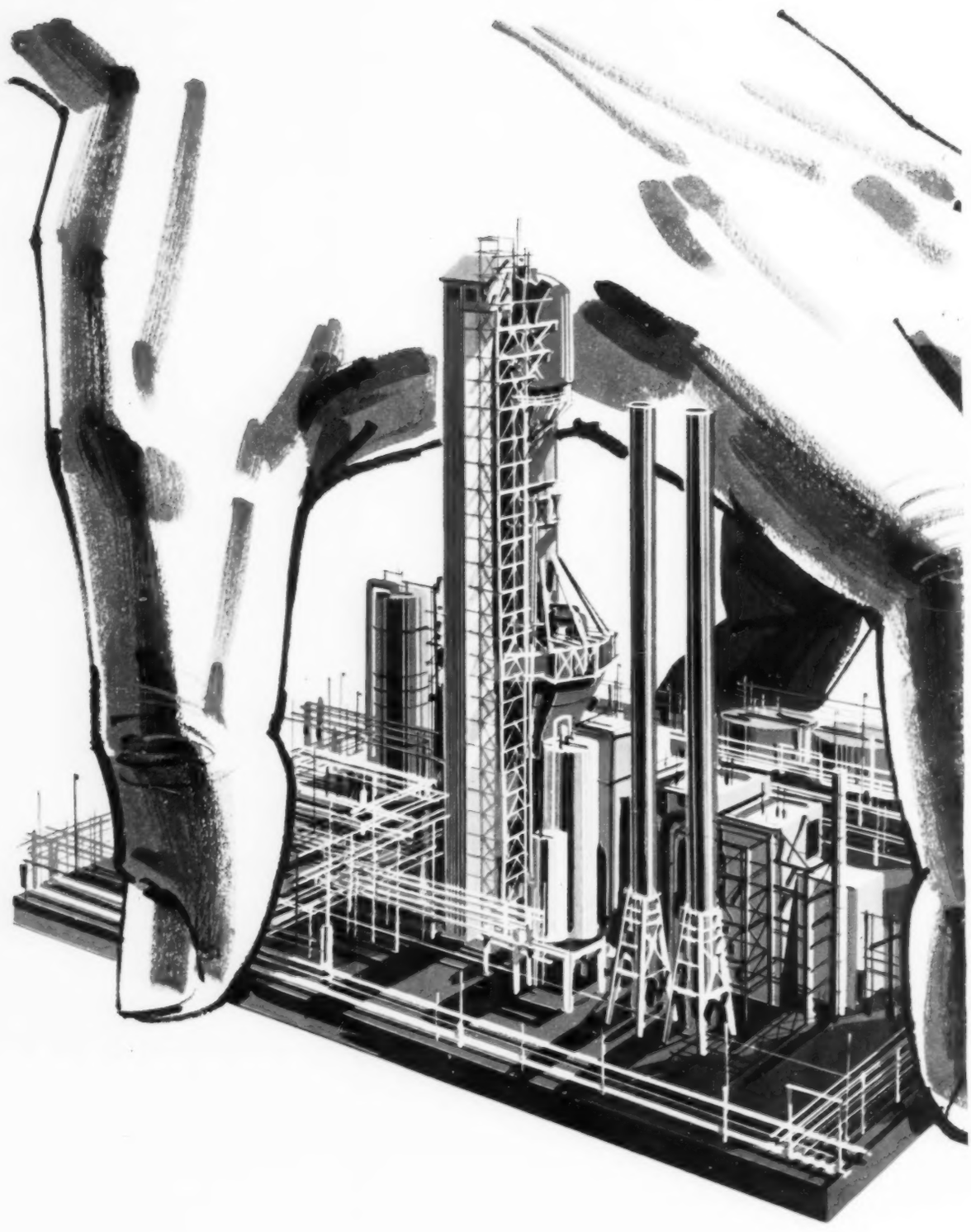
Why do sweater girls look to the oilman? Simple. He's responsible for the petroleum-based synthetic fibers that go into so many of the sweaters they wear. And for the petroleum-based synthetic dyes that are used to color them. Because of oil research, clothing for the whole family has better appearance and longer life. Each advance in oil technology gives you, the oilman, a greater stake in society. And gives you more reason to speak up when anyone speaks out against oil. Today, everyone enjoys the benefits of oil—one of nature's most versatile resources.

SHELL OIL COMPANY



Foster Wheeler *Heat Engineered* **products, plants and processes...for the world's industrial progress.**

Experience engineers your plant and puts it where you want it

The ideal objective in planning your process installation is to arrive at the most direct and economical route to your production and quality requirements.

If anything can bring you close to this ideal, it is experience . . . and this is what Foster Wheeler has to offer . . . unusually broad experience in process design, engineering, procurement, construction and plant start-up. The adaptability of this experience has been demonstrated by over 800 successful major installations in 41 nations.

FW engineers have established their ability to meet guarantees for quality, cost and production. In addition, they have found and developed hidden opportunities in many processes for still greater cost reduction and for improved performance. If you are considering a new process installation, it will profit you to discuss your requirements with Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.

FOSTER FW WHEELER

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BEHIND THE MACHINE

Advanced designs; a wide range of types and sizes; high performance figures; these are the results of over twenty years' experience of design, research and manufacture of gas turbines by AEI engineers.
AEI gas turbines have been installed in aircraft and merchant ships and in frigates and destroyers of the Royal Navy. Industrial machines are suitable for every mechanical drive application as well as power generation, and they have output ratings of 1,750 kW and upwards.

The picture shows work on the rotor of an L21C gas turbine being built for the Basrah Petroleum Co. Larger machines of similar design —the L51C—were recently installed in Iran to supply power for the electrification of the Gach Saran oilfield.

Produced on behalf of AEI Turbine-Generator Division, Britain's largest manufacturer of turbine-generators.

AEI Associated Electrical Industries Export Ltd

33 GROSVENOR PLACE, LONDON SW1

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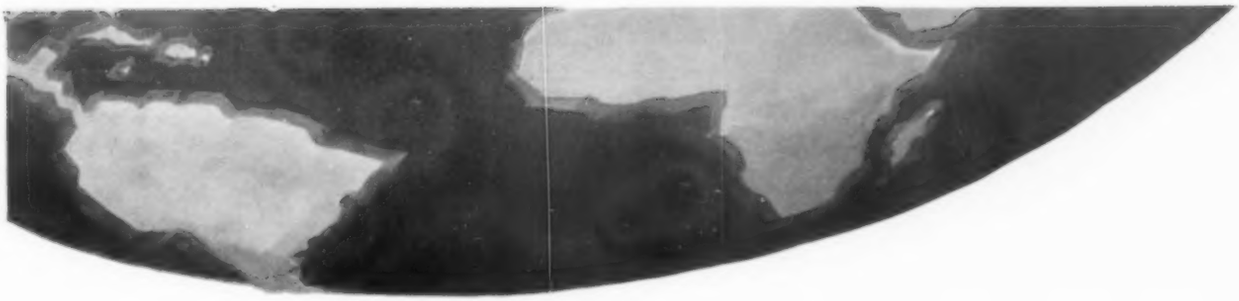

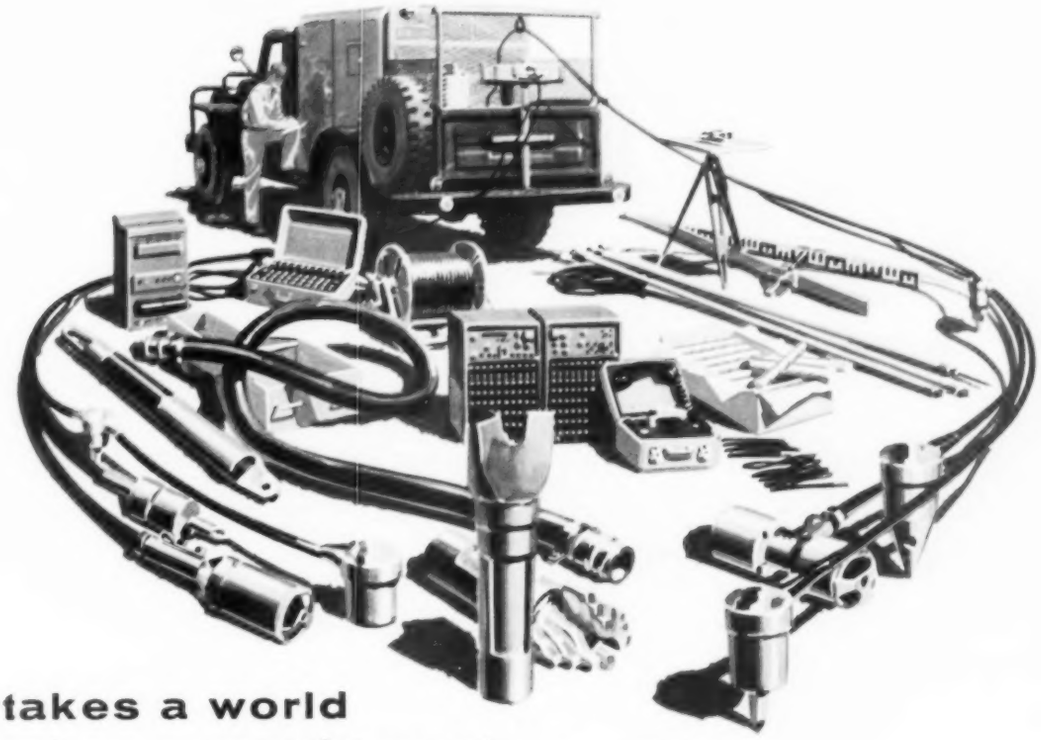

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. . . to be successful in today's world-wide search for oil. In geophysical work, no report is worth more than the weakest link in its preparation. That's why Rogers Companies use only the best men and equipment—backed by world-wide experience—to give you the best in geophysical prospecting. Remember Rogers for results!

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ROGERS' CREWS GO EVERYWHERE

We don't change the name..

The only similarity between today's OSC-1G and the old OSC-1G is the name

Like all other Hughes bits, the OSC-1G is being constantly improved. One change opens the door to others. Our engineers are never satisfied. They are challenged by new facts from the field and our continuing search to find new ways to improve bit performance. That's why you'll get the most hole today from Hughes bits. And why you'll get more tomorrow. You keep hole costs down when you go all the way with a Hughes bit program.

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.we change the performance

Seven specific improvements make the **Hughes OSC-1G** *a faster-digging bit with longer drilling life*

To assure faster penetration: 1) Cones have been given more twisting, tearing, gouging action. 2) Teeth have been lengthened to take full advantage of this action. 3) Bearing capacity has been increased to sustain heavier weights. 4) Heel and inner rows of teeth have been redesigned to increase penetration rate. 5) Teeth have been added to the spearpoint to improve the cutting action in the center of the hole.

To assure longer bit life: 1) Teeth have been strengthened. 2) Hardfacing on the teeth and gage has been improved to extend the cutting life of the bit.

Increasing the bearing capacity, which permits the application of heavier weights on the bit, is increasing footage as well as penetration rate. In addition, these improvements are increasing the range of formations in which the OSC-1G is being used.

HUGHES®

ORIGINATOR AND WORLD'S LEADING DEVELOPER OF CONE-TYPE ROCK BITS

A little error, obviously . . .

embarrassing, to arrive
like this on a date . . .
but how much greater
your consternation
if you fail to select
the right catalyst
for your process.

We furnish
high quality
Cracking Catalysts
in bead form
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Houdriflow-Units

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We furnish
Platinum Catalysts
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Atlantic 16 Catalyst
for Reforming Processes

KCE

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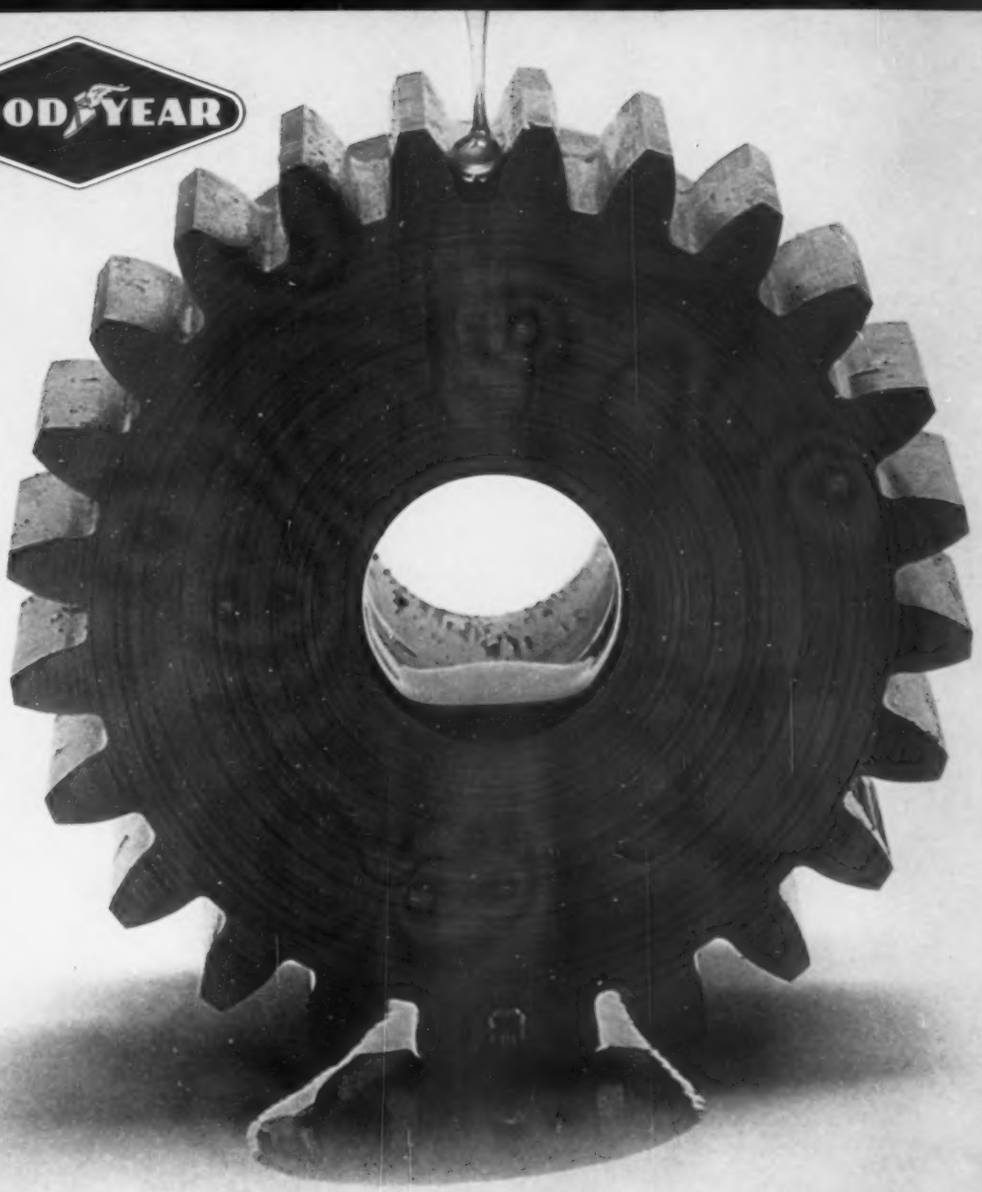
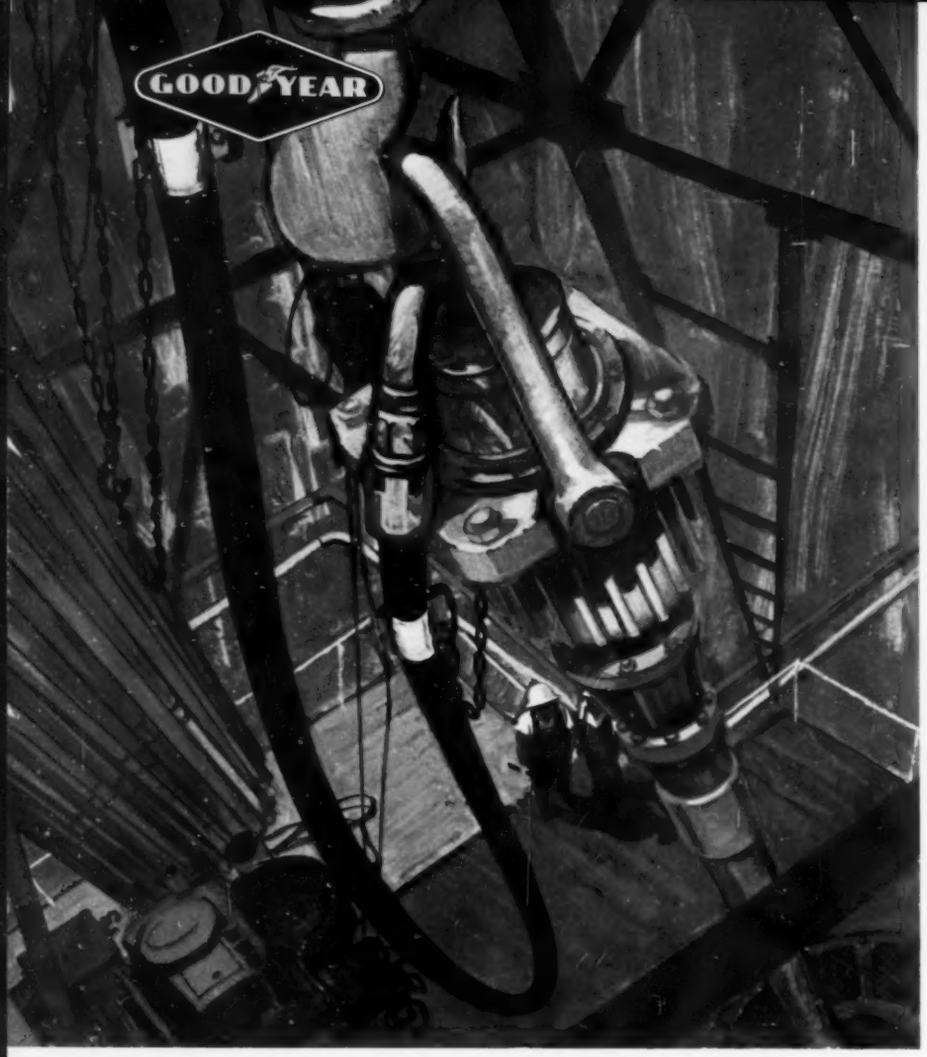


When you
handle oil

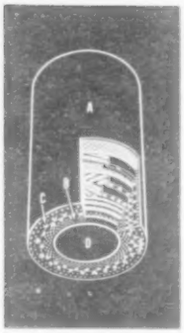
GOODYEAR

makes
what you need

From drilling rig to distribution, oilmen the world over rely on Goodyear products. With its unrivalled experience in the industry, Goodyear is a name well known in every phase of handling oil.



...FOR MAJOR OIL FIELDS AND REFINERY PORTS

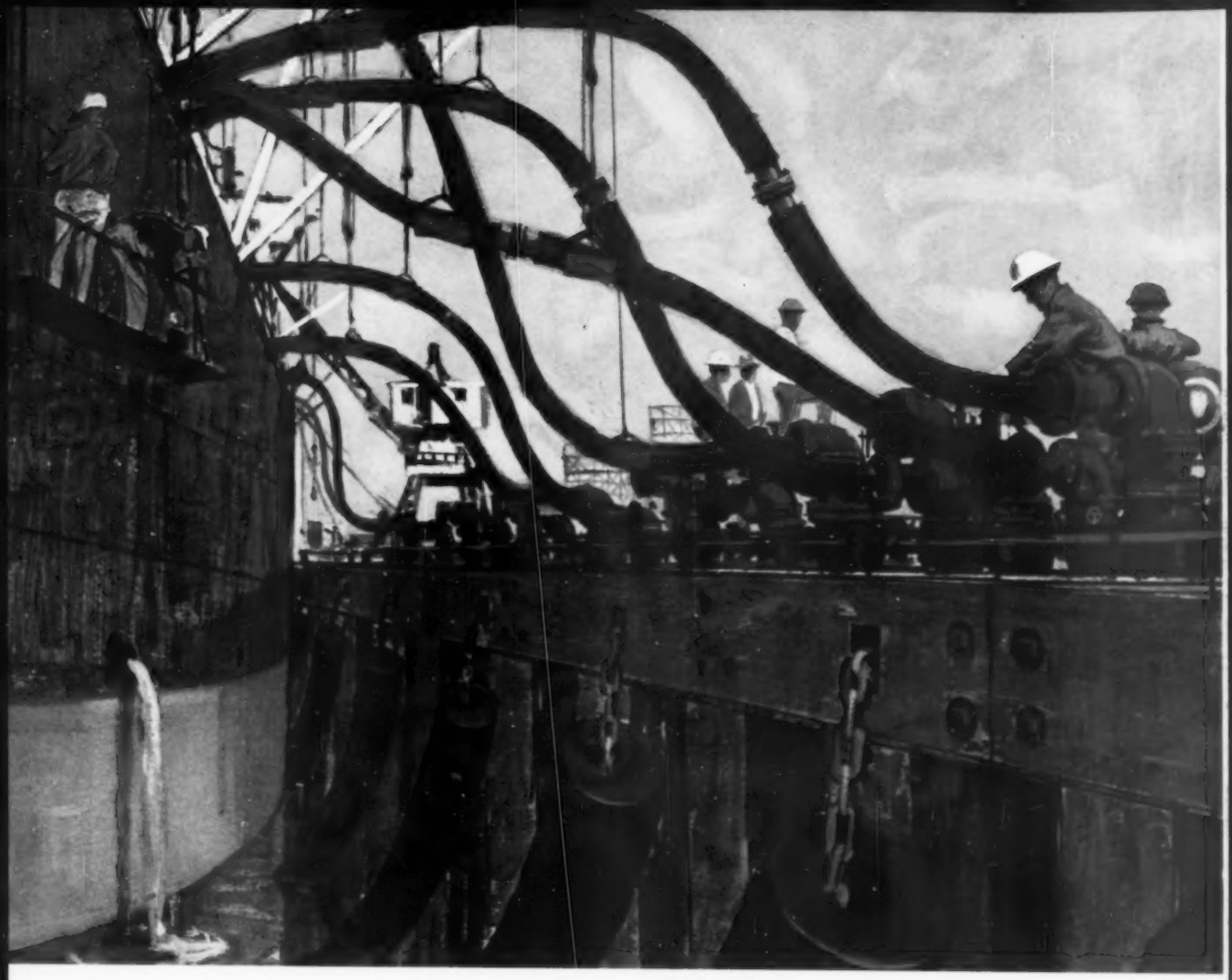


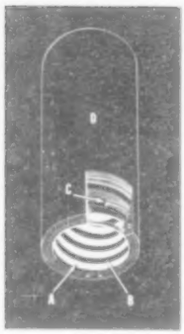
3153 H HIGH-PRESSURE ROTARY HOSE. This crush-, kink-, and weather-resistant Rotary Hose is unsurpassed in ruggedness of construction. Where rock is hardiest, bottom-hole pressure most extreme, Goodyear hose outstrips all others in performance, endurance . . . and economy!

3153 H High-Pressure Rotary Hose

A. Cover of extra heavy gauge compound resists gouging, weathering and wear.
B. Plies of heavy fabric plus high-tensile cable steel wire and wire helices at ends for exceptional strength with flexibility.
C. Fabric breaker strip.
D. Heavy mud-, abrasion- and oil-resistant tube.

Oil leads men over razor-edged rocks and shifting sands to places where no one's ever been—Goodyear helps them get there. While they search, Goodyear guards their fuel in collapsible rubber Pillow Tanks. When oil is found, Goodyear tires bring in drill rigs. Goodyear hoses assist drilling, load tankers, feed refineries, fill your tank. From discovery to distribution, when you handle oil, Goodyear makes what you need.





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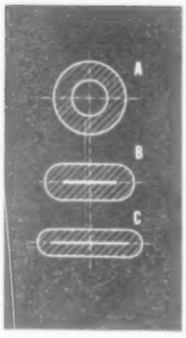
Goodyear Oil Suction and Discharge Hose records up to 300% better service – best insurance against profit-shrinking tie-ups and premature failures! Oil, gasoline, solvents, even asphalt–MH Oil Hose handles them with ease. Goodyear designed it for the toughest assignments. It outlasts ordinary hose by far!

Style MH Oil Suction & Discharge Hose (RB)

A. Helix of flat, noncorroding, galvanized steel wire plus ply of heavy fabric coated with oil-resistant compound.
B. Tube of gasoline- and oil-resistant synthetic rubber.
C. Reinforcing plies of heavy fabric plus helix of round steel wire.
D. Oil-, age-, abrasion-, and weather-resistant cover.



ALL-RUBBER DOCK FENDERS.

Built for extra heavy shocks, Goodyear All-Rubber Dock Fenders soak up thousands of foot-pounds of kinetic energy per foot without significant reaction. This remarkable absorption-power cuts dock piling costs! The fender resists mildew and the destructive action of salt water, ozone, sunlight and marine bacteria. Outlasts other types of fendering with minimum maintenance!

Cylindrical Dock Fenders for protection against shock, abrasion and crushing action

A. Uncompressed 15"size–inside diameter 7½".
B. Compressed by load of 5 tons (approx.) per foot–bore closure 7½".
C. Compressed by load of 110 tons (approx.) per foot–bore closure 11".

GOODYEAR

...FOR FUEL DEPOTS—FLEXWING TANK TRUCK HOSE.

For loading or unloading tank trucks, tank cars or storage tanks, Flexwing Tank Truck Hose is sturdy, strong, yet flexible, even in sub-freezing temperatures. Highly resistant to crushing or kinking, Flexwing handles working pressures up to 200 pounds. And, it's wire bonded for positive dissipation of static electricity.

FLEXWING TANK TRUCK HOSE

Sturdy cover is oil-, gasoline-, sun-, weather- and abrasion-resistant.
Reinforced with two braids of horizontal braided synthetic cord plus wire helix.
Smooth, synthetic rubber tube is oil-, and gasoline-resistant.

Flexwing—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio, U. S. A.

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That's how far ahead we're thinking

The success of our company depends upon the drilling fluids we evaluate and develop for decreased drilling costs . . . in 1981 we hope to be the major mud supplier for the world's oil industry. That's why a portion of every dollar you spend with Milwhite today is reinvested in research for tomorrow.

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SYMBOL of Highest Quality Technology

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BRONZE
IRON
STEEL
ALLOY STEEL

These valves are produced in the unique plant of the KITAZAWA INDUSTRY CO., LTD., Japan's largest manufacturers of these articles. By means of its skilled technicians and up-to-date machinery, the Company handles its own wide range of production from designing, metalurgical processing, machining, and assembling to the final inspection and testing under modern quality control systems.

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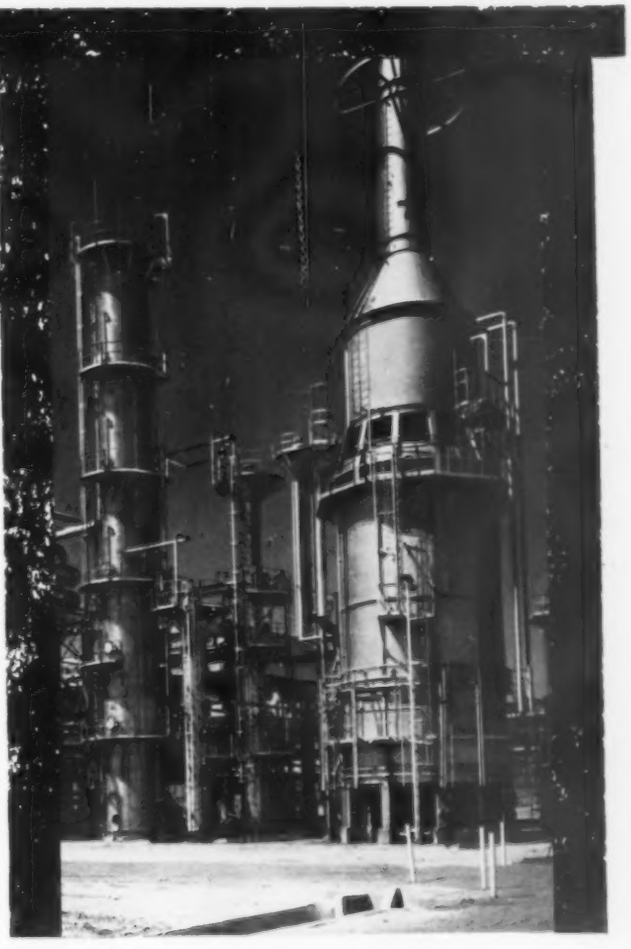
Procon completes African refinery 4 months ahead of schedule

Sixteen months to build a refinery in Mozambique . . . on the east coast of Africa near the port of Lourenco Marques . . . at considerable distances from the industries where almost all the refinery equipment had been constructed.

But build it Procon did! Not in 16 months--but in 12 months. Four months ahead of schedule! A modern 12,000 BSD refinery, it includes Platforming®, Unifining®, Merox™, and crude distillation units plus complete supporting facilities.

On stream for Sociedade Nacional de Refinacao de Petroleos (SONAREP) a subsidiary of the Portuguese petroleum marketing firm, Sociedade Nacional de Petroleos (SONAP), this refinery is another tribute to Procon's proven capabilities . . . to tackle the toughest job . . . and complete it in the shortest possible time.



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World-Wide Construction for the Petroleum, Petrochemical and Chemical Industries

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MOBIL RESEARCH ANNOUNCES THE DEVELOPMENT OF THE
FIRST MODERN CRITERION OF TOTAL GASOLINE PERFORMANCE

The Megatane System of Rating Gasoline

Based on a five-year study of gasoline performance characteristics, the MEGATANE Rating System overcomes the inadequacy of partial ratings (such as octane) and provides an all-inclusive rating of gasoline performance.

As every gasoline technologist knows, octane rating is an important factor in the evaluation of gasoline. He also knows that it is far from the total measure of gasoline quality.

Since the octane rating was introduced 34 years ago, brilliant advances have been made in petroleum technology. For example, the invention of platinum reforming provides a means of producing a higher-energy gasoline that satisfies today's high-powered motors. Metal deactivators were developed to prevent carburetor gum deposits that foul carburetors and stick chokes. Phosphorous additives were developed to neutralize harmful combustion deposits and to give longer spark plug life. Detergent additives were introduced to keep carburetors clean.

These and many other characteristics are important to the gasoline user today. Unquestionably, there is a great need for a broad standard of gasoline performance that recognizes all of these factors. It is this need that Mobil research has sought to answer.

Development of the MEGATANE Rating System

The MEGATANE Rating System evolved from analysis of the many desirable performance qualities of a gasoline. This was coupled with an intensive study of the primary benefits and secondary effects of providing these qualities. This was important because in many cases these secondary factors altered the primary benefits, sometimes with unfavorable side-effects.

After long consideration and discussion, a large group of performance qualities was isolated as representing the important properties of today's ideal gasoline.

Evaluation of all these qualities was a complex undertaking—for the goal was not only to evaluate the qualities of a gasoline, but to be able to predict the gasoline's performance.

The MEGATANE Rating System

Our MEGATANE Rating System accommodates all the important qualities in today's gasolines. The MEGATANE rating of any gasoline is the total number of **effective** qualities it possesses on the MEGATANE scale.

In order to be **effective,** the quality must not only provide the performance advantage for which it is intended, but it must be free of adverse side effects which would cause trouble. This condition indicates the need of quality controls which define the effectiveness of every quality feature on this overall basis.

For example, high volatility is desirable to provide good cold engine response for fast acceleration. However, if the volatility is too high, so that it "vapor locks" the engine, it is no longer effective and no credit for this feature is given in the MEGATANE Rating System.

Another example, an **effective** carburetor deicing additive must not only efficiently combat stalling that occurs under icing conditions, but it must also be free from any adverse characteristics such as emulsification or chemical reaction that could shorten fuel filter life or foul carburetor operation.

In all such cases, the MEGATANE Rating System does not credit the positive advantage unless it is actually provided and unless it is free from any harmful effects such as indicated above. Both of these conditions must be satisfied to consider a quality **effective** in the MEGATANE Rating System.

The Octane Measuring Stick

The widespread use of octane ratings as a measuring stick of gasoline quality has been valuable to the extent that it has rated an extremely important factor in gasoline performance during an era of rapidly increasing engine compression ratios. This trend, however, has now sharply decelerated. Now there is a real need for a broader and more meaningful rating—one that goes far beyond octane rating in scope.

We believe that the MEGATANE Rating System is an important step forward in the attainment of such a goal. It is the first system to take into account all the important performance factors that enter into today's complex modern gasolines.

A gasoline skilfully formulated to meet high MEGATANE standards will provide, in the opinion of Mobil engineers, dependable total performance in today's cars over the widest possible range of driving conditions.

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1 Many of the computer programs in Kellogg's extensive library have been developed jointly by process engineering and computer specialists.

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The new computer and improved programming techniques mark another major stride in Kellogg's continuing improvement of its engineering services. Its speed makes practical rigorous calculation and the evaluation of multiple solutions to difficult design problems—a vital step in achieving the most economic design.

The computer's large capacity will enable Kellogg to develop new methods which can be applied to plant engineering problems. In addition, it will permit Kellogg to broaden its present activities in such areas as computer control, process dynamics, and systems engineering.

New engineering techniques and increased engineering efficiency are vital to the creation of optimum plants. If you are planning a new plant, Kellogg engineering services, more than ever, can help you achieve optimum plant design and a more economic investment.

2 Engineering data and computer commands, punched on cards and stored on magnetic tape, are read into the computer.

3 A printout provides engineering data ready for evaluation. Simplified methods permit ready use of computer for solving a wide range of process and mechanical design problems.

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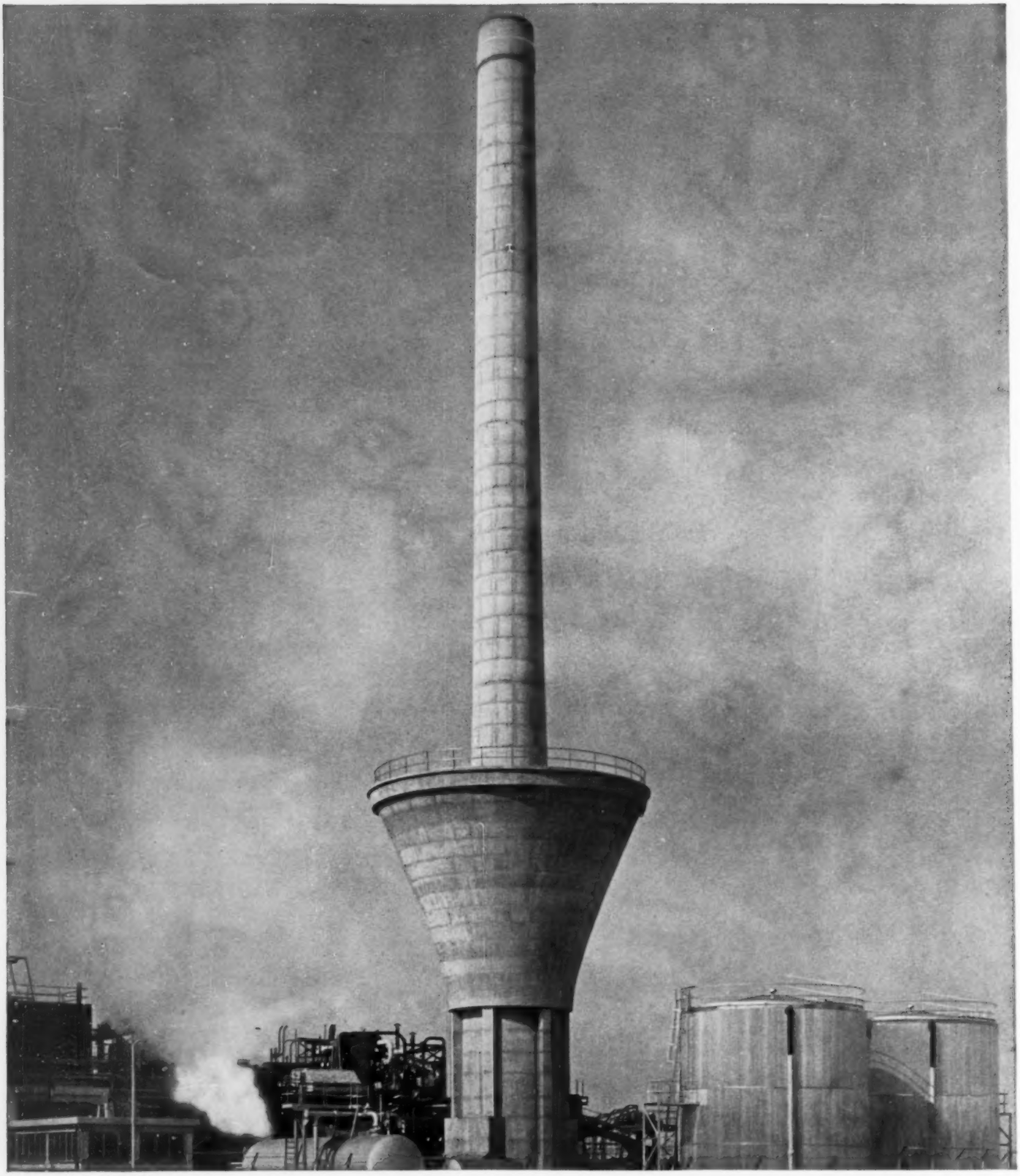

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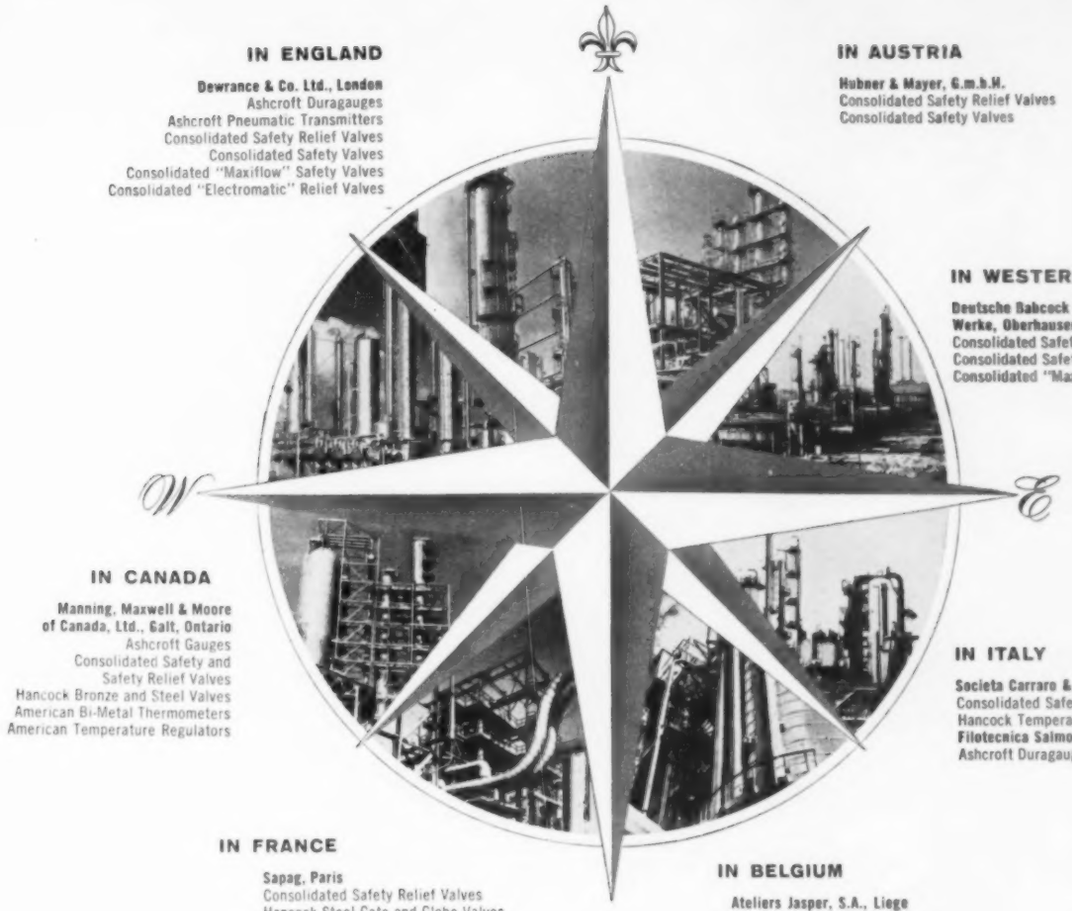

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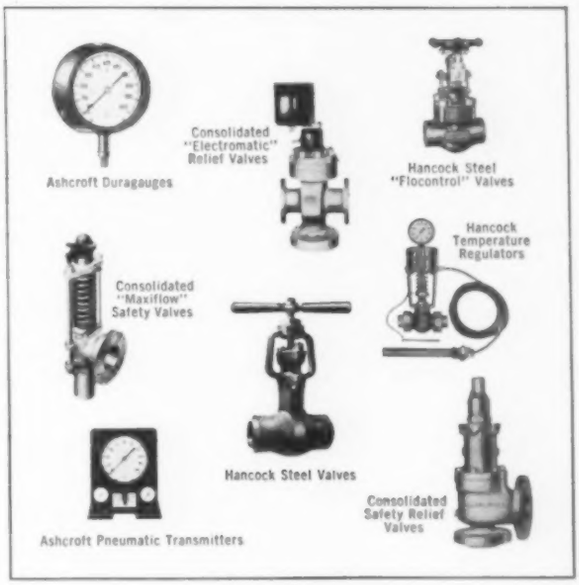

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by William C. Uhl
Processing Editor

Highlights of the month—new cracking catalyst treating technique is aimed at reducing effects of metal contaminants in feedstock; mobile computers help show management the need, or the lack of need, for full-scale process control computers

The perplexing problem of catalyst contamination by metals in cracking unit feed may have been solved as the result of a new technique under development by Atlantic Refining Co.

Process efficiency is increased through reduction in coke formation and lowered conversion of charge to light hydrocarbons. Atlantic says, because the new process selectively removes active metal contaminants deposited on the catalyst. No further information on how the process is carried out has been revealed, and commercial scale tests are just now getting under way at the company's refinery in Philadelphia. However, data on pilot plant studies have been reported in a paper presented at the Lake Placid, N. Y., meeting of the American Institute of Chemical Engineers by W. J. Fowle, G. P. Masologites, H. R. Grane, and I. E. Katz of Atlantic.

In the pilot runs, cracking was carried out at a 50% conversion, once-through, with metals content of the feed comparable to commercial operation, and temperature-pressure conditions in reactor and regenerator similar to a commercial unit. The process involved daily removal of 11% of the catalyst from the regenerator, treating it for removal of active metal contamination, and returning it to the cracking unit.

In a run over some 40 days, the following results were obtained:

Catalytic coke went down, from 3.3 wt-% at start-up, to 2.5 wt-%. By comparison, in a run without the deactivation of contaminants, coke rose to 4.2 wt-%. Hydrogen production dropped markedly, indicating a substantial lowering of gas-handling needs. It went from about 230 SCF/bbl (of feed) at start-up to approximately 125 SCF/bbl. Without the special treatment, it had risen to 275 SCF/bbl. Yield of butane and heavier materials increased by over 3 wt-%.

Atlantic states that the process will reduce the coke-producing factor of the catalyst to 1.0, or the equivalent of a clean catalyst. Metals remaining on the catalyst are not reactivated when the catalyst returns to normal cracking and regeneration conditions. Part of the increased cracking activity is lost; however, the resultant activity remains higher than it would be with untreated catalyst after similar exposure.

Mobile computers may turn out to be an economical way for process plant management to learn whether or not full-scale permanent installations will pay off or are needed at all. They can also point up other non-computer routes to improving plant productivity.

Trial runs with this type of equipment have been shown to succeed by Phillips Petroleum Co., and today a number of other firms—among them Shell Chemical and Monsanto—are reportedly trying similar experiments. What Phillips did essentially was to pack a computer and its related equipment into a trailer which could be rolled to desired locations in the plant, be tied into the process unit and be given a trial run.

In the first tests, at the company's Sweeny, Texas, ethylene plant last year, a computer—North American Aviation Autonetics Div. Recomp II, leased at about $2500 a month—was used to analyze plant operating characteristics and assist in developing better operating methods. Eventually it operated the plant under closed-loop control during the tests.

After five months of trials, results showed production increased a very attractive 16%. However—and this is the intriguing part of Phillips' findings—a subsequent study showed that 10 out of the 16% improvement could be attributed to permanent process operating improvement, based on what the computer had shown about variables.

In other words, a 10% gain in productivity could be attained by continuing to apply what had been learned. The remaining 6%, which was achieved by the computer itself, could not be justified on the basis of computer rental costs. Now, the company is trying the mobile computer on a 70,000 b/d catalytic cracking unit at its Borger, Texas, refinery. In this case, Phillips says a 1.5% improvement in productivity would yield some $500,000 a year for the additional products.

World's heaviest single piece of equipment ever erected for gasoline production, a more-than-400-ton reactor for Standard Oil of Ohio's new 7,500 b/d Isocracker at Toledo, Ohio. It was built by Chicago Bridge and Iron Co. and shipped by special train from Birmingham, Ala. Work at Toledo is by Ralph M. Parson Co.

The company has five major objectives in its trial on the catalytic cracking unit:

(1) To determine the extent, frequency, and cost of process disturbances—such as excessive black smoke from the stack. These are the result of maladjustments which waste feedstock and lose product.

(2) To establish more accurate mathematical relationships between controls and profitability at various operating conditions.

(3) To improve techniques and measurements; for example, finding the best location in the product stream to take samples.

(4) To evaluate all the new methods of operation which develop during the experimental work, and

(5) To choose those that appear most promising and give them extended tests.

Who invented thermal cracking? For a long time we had been under the impression that the answer would have to include such names as William M. Burton, E. M. Clark, A. S. Hopkins, C. P. Dubbs, Walter and Roy Cross, Holmes, Manley, and perhaps many others.

More recently, however, it would appear that claims for earlier work have been made from behind the Iron Curtain. Whether these claims have been based on fact or fancy would seem to us to be largely affected by possible political overtones. One point is certain, however. The various claimants ought to get together and "compare notes," before making public their statements.

For example, the Moscow paper *Ekonomicheskaya Zhizn* has now claimed that a Russian Engineer, B. G. Shukov, invented the cracking process as early as 1890, while the American Burton obtained the patent for his cracking process, "which he copied from the Russian," in 1912.

Earlier, in January, 1956, the Hungarian newspaper *Nepujsag* had stated that the oil cracking process had been invented by three Russian scientists in the middle of the last century, and later had been "brought to perfection" by the Russian engineer, Shukov.

Shukov, according to the Moscow report, allegedly constructed an apparatus for the distillation of crude oil at high temperature and under pressure. In consequence of various patent litigations between competing American petroleum companies concerning the cracking process, a delegation of USA engineers even went to Russia to see Shukov on this matter and obtain from him the assurance that the first description of the cracking process was to be found in his patent application.

What's New in Processing Plants

Contract signed—by Thai Oil Refinery, a Bangkok company backed by Shell Oil, for construction of a $35 million, 40,000 b/d refinery near Sriricha, 90 miles east of Bangkok, Thailand, on the Gulf of Siam, for completion in two years. Summit Industrial Corp., backed by Phillips Petroleum, has also won a bid for construction of a 30,000 b/d refinery but has not yet signed a contract.

• • •

Contract awarded—to Foster Wheeler Ltd., for design, engineering, procurement and construction of the 70,000 b/d refinery at Reunion Rocks, near Durban, South Africa, for South African Petroleum Refineries (Pty) Ltd. (50-50 British Petroleum and Royal Dutch/Shell). Completion: end-1963.

• • •

Planned—an additional process unit, a 6,450 b/d Isocracker, at new refinery being built at Frankfurt am Main, Germany, by Caltex Oil (Germany) GmbH.

• • •

Planned—expansion of the Regent Refining Co. (Canada) Ltd. refinery at Port Credit, Ont., to 35,000 b/d from present 26,000 b/d, at cost of $3.8 million, including new crude and vacuum stills and auxiliaries, for completion mid-1962.

• • •

Planned—a 24,000 b/d refinery at Dakar, Senegal, for completion end-1963, by Soc. Africaine de Raffinage, a new firm composed of French government interests, a French Senegalese bank, and with 60% held by present marketers: Shell, Esso, Texaco, BP, Mobil, and Cie. Francaise des Petroles. Plant will operate on Franc-zone crude oil from Equatorial Africa and possibly Sahara and Nigeria.

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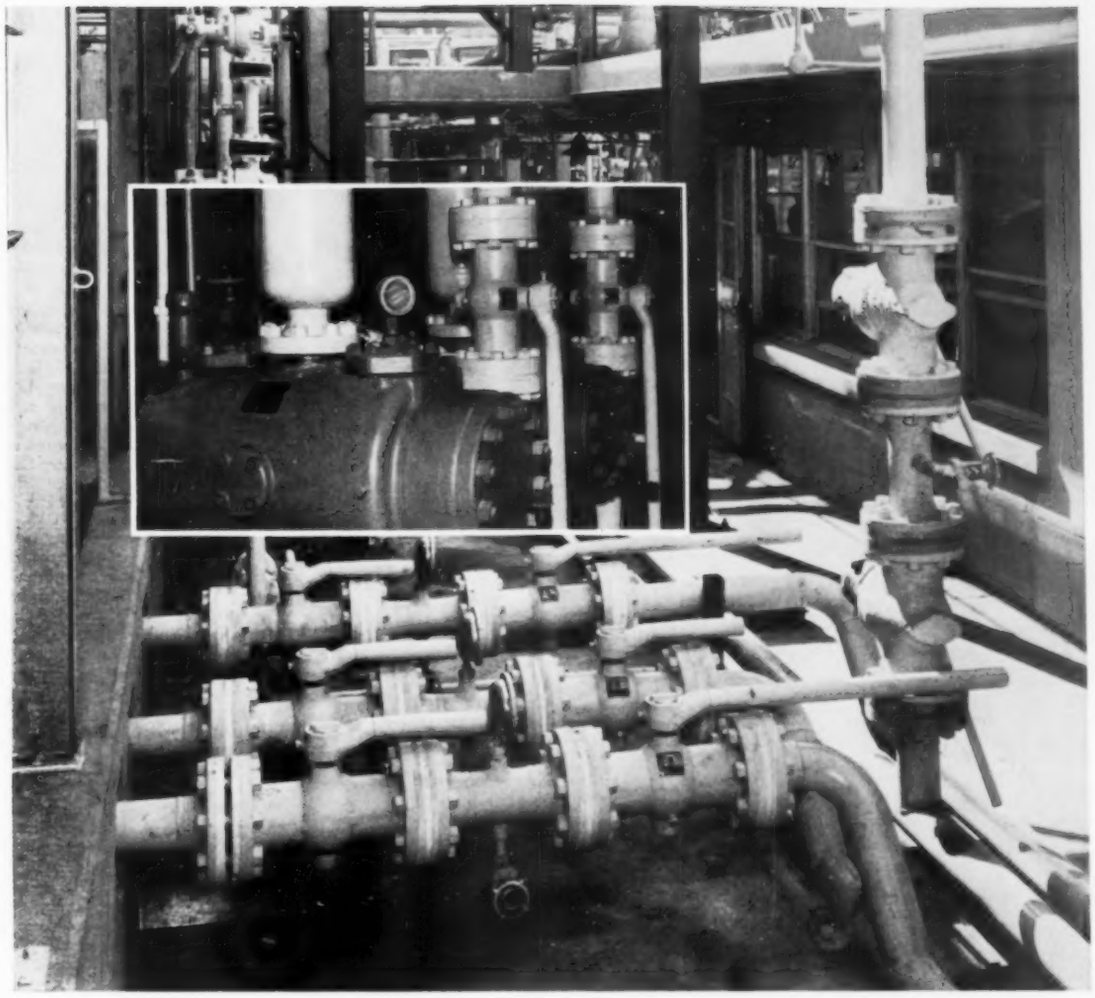
(Continued on page 38)



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(*Continued from page 36*)

Planned—a 16,000 to 20,000 b/d refinery at Abidjan, Ivory Coast, by French interests.

• • •

Planned—a $2.8 million plant to produce and regenerate UOP-type reforming catalyst, at Kiratsuka, Kanagawa Pref., Japan, by JGC-Universal Co., a new firm established jointly by Japan Gasoline Co. and Universal Oil Products Co. Completion: one year after government approval is granted.

• • •

Site option acquired—by Gelsenberg Benzin AG, for its planned 40,000 to 50,000 b/d refinery in Bavaria, Germany, near Neustadt, 20 miles from Ingolstadt. Completion: 1964. It is reported Gelsenberg will have partners in venture, possibly Mobil.

• • •

Cost revealed—of capacity increase by 100,000 b/d by Soc. Industrielle Belge des Petroles at Antwerp, Belgium, at $30.8 million. Completion: spring of 1963.

• • •

Planned—a medium-sized refinery near Tehran, Iran, by National Iranian Oil Co., as well as a second trans-Iranian oil pipeline from Abadan area to Tehran and a natural gas pipeline from Sarajeh field to Tehran.

• • •

Completed—an 85,000 b/d, three-stage crude distillation unit, at Tulsa, Okla., refinery of DX Sunray Oil Co., replacing five other units which had a combined capacity of 75,000 b/d. It is the first such unit in the USA with electronic computer control incorporated in the original design. Computer is a Thompson-Ramo-Wooldridge TRW-300.

• • •

Contract awarded—to Catalytic Construction Co. by Atlantic Refining Co., to increase capacity of the 5,500 b/d alkylation unit at Point Breeze, Penna. refinery to 7,500 b/d.

• • •

Contract awarded—to Foster Wheeler Corp., by Humble Oil & Refining Co., to design and construct a 400,000 lb/hr (steam) waste heat boiler, operating on combustion gases from the fluid catalytic cracking unit, at Bayway refinery, Linden, N. J.

• • •

Refining rights granted—by Dominican Republic, to Thomas A. Pappas and Associates of Boston, who is reported to be planning a 10,000 to 15,000 b/d refinery.

• • •

Planned—a 1,000 b/d refinery at Elat, Israel, by Sonal, a local company. Products proposed are kerosine, diesel fuel, and fuel oil.

• • •

Completed—the 20,000 b/d refinery of Istanbul Petrol Rafinerisi A. S. (Caltex 49%, Turkiye Petroleri A. O. 51%), at Izmir, Turkey.

• • •

Contract awarded—to M. W. Kellogg Co., by Empresa Colombiana de Petroleos, for expansion and modernization of the 37,500 b/d refinery at Barrancabermeja, Colombia, including a 9,200 b/d vacuum still, and a phenol extraction unit. Completion: fall 1962.

• • •

Planned—$48 million, 80,000 b/d refinery by Italian state company ENI, at San Nazaro dei Burgondi, Italy, with completion in 1963.

• • •

Plans solidifying—For $50 million investment in two refining installations on Mexico's west coast, by Petroleos Mexicanos, as result of pending approval of a $34 million credit by French banking interests. A 50,000 b/d plant at Mazatlan will include atmospheric and vacuum distillation, 20,000 b/d catalytic cracking, polymerization, ancillary units, and a tanker berth. Fluor has engineering contract, and some UOP processes will be used. The second plant, a 30,000 b/d coking unit near Tiajuana, will use Esso Research and Engineering's fluid process, be built by Arthur G. McKee & Co. Residual feedstock will come from new Mazatlan refinery as well as from Pemex plants at Ciudad Madero and Minatitlan.

• • •

Planned—a 10,000 b/d distillation and coking unit, by Gewerkschaft Erdoel, at Lingen, Germany, for completion late in 1962.

• • •

Completed—a 7,000 b/d UOP Udex extraction unit at British American Oil Co. Ltd.'s, Montreal, Quebec, refinery.

Planned—a 750 b/d lube oil unit, by Esso Nederland at Rotterdam, the Netherlands, for completion by end-1962.

• • •

Contracts awarded—by Soc. de la Raffinerie de Strasbourg for its 66,000 b/d refinery to be completed in 1963 at Strasbourg, France. PIC Engineering will build crude still and gasoline treating units. McKee-Head Wrightson will provide process design, basic mechanical design and general supervision.

• • •

Proposed—by Ente Nazionale Idrocarburi, the Italian state company, a refinery at Dar es Salaam, Tangayika. Caltex and Stanvac have also made proposal to the local government previously.

• • •

Planned—a $1.6 million natural gas plant near Edmonton, Alberta, by Steelman Gas Ltd., to handle 70 mmcf/d of gas and extract about 1,300 b/d of propane and 465 b/d of butane for completion fall of 1962.

• • •

What's New in Petrochemicals

Planned—a $6.5 million plant to produce naphthalene and other petrochemicals, including aromatics, by Commonwealth Oil Refining Co. Inc., adjacent its refinery at Ponce, Puerto Rico, for completion about end-1962. with designed capacity of 50 million lb/yr of naphthalene, and using UOP licensed Hydeal process.

• • •

Planned—a $3.2 million investment in new plants in Mexico, by Reichhold Chemicals de Mexico, S. A., over coming three years, possibly at Cuernavaca, including units to produce phthalic anhydride, formaldehyde, plasticizers and synthetic resins.

• • •

Planned—by Chimica Sarda SpA (jointly owned by Rumianca SpA and Pittsburgh Plate Glass international S. A.), a plant at Sardinia, Italy, to produce glycerine, tri- and per-chloroethylene and ethylene dichloride, using PPG-developed processes.

• • •

Planned—a 20,000 ton/yr cis-polybutadiene plant, by Soc. Elastomeres de Synthese, at Berre, France, for completion end-1963, under terms of an agreement by which the company will have exclusive license for Shell, Goodrich-Gulf, and Montecatini patents during first few years of production and right to produce and use Ziegler catalysts.

• • •

Contract awarded—to Constructors John Brown Ltd. by Polimex, the Polish government trade organization, to design and construct three tonage oxygen and nitrogen plants for ammonia production, with a combined output of nearly 365,000 ton/yr of oxygen and over 365,000 ton/yr of nitrogen, at cost of almost $6 million, and using Hydrocarbon Research Inc. air separation process.

• • •

Completed—the 10,000 ton/yr methanol-from-natural gas plant of HIAG Werke, Vienna, Austria.

• • •

Planned—a $2.2 million expansion in propylene facilities at the Marcus Hook, Penna., refinery of Sun Oil Co., from present 120 million lb/yr to 300 million lb/yr, for completion about mid-1962.

• • •

Contract awarded—to Soc. Etudes et Recherches Industrielle, Belguim, from Soviet Techmashimport, for an ammonia plant based on the process of Soc. Belge de l'Azote et des Produits Chimiques du Marly, of Liege.

• • •

Completed—a highly automated plant to process acetone into diacetone alcohol, mesityl oxide, and methyl isobutyl ketone, at Germiston, near Johannesburg, South Africa, by Kolchem Ltd. (a joint venture of SASOL and National Chemical Products Ltd.). Work is scheduled to start soon on two other units for pentaerythritol and hexylene glycol.

• • •

Postponed—plans by Kohle-Oelchemie GmbH for its $25 million plastics plant in West Germany.

• • •

Acquired—a substantial interest in Ammoniaque Synthetique et Derives, a subsidiary of Evence Coppee & Cie of Brussels, Belgium, by Cities Service Co., thus providing Cities Service a position in the European Common Market in chemical and other fields. ASED is engaged in producting and marketing nitrogen fertilizers, coke, and chemicals. Other cooperative enterprises between Cities Service and Evence Coppee are under consideration in the Common Market area.

Contract awarded—to Fluor Corp. for engineering, procurement, and construction of benzene facilities at Beaumont, Texas, by Mobil Chemical Co., to include a 2,300 b/sd gasoline hydrotreater and 12,500 b/sd UOP Udex unit. Completion, February, 1962.

• • •

Contract awarded—Badger Mfg. Co. by California Oil Co., for design, engineering, and construction of a 30 million lb/yr phthalic anhydride plant at Perth Amboy, N. J., for completion fall of 1962, using California Research Corp.'s fixed bed process (oxidation of orthoxylene).

• • •

Planned—a million lb/yr plant at McCook, Ill., by Universal Oil Products Co., to produce rubber additives, a new material developed by UOP to protect rubber against deterioration by ozone.

• • •

Planned—a $6 million isocyanates plant in France, by Dekachimie, recently formed by du Pont and Establissements Kuhlmann, for completion in 1963.

• • •

Planned—an increase in capacity of its polyethylene plant at Gelsenkirchen, Germany, by Scholven-Chemie, to 12,000 ton/yr. Recently completed, a 10,300 ton/yr isopropanol unit.

• • •

Completed—facilities for tonage manufacture of a new ethylene-propylene rubber, by Enjay Chemical Co., at Baton Rouge, La., using a process developed by Esso Research & Engineering Co., and polymerization catalysts licensed by Ziegler.

Trimethyl Phosphate for Chemical Uses

Trimethyl phosphate, marketed by Ethyl Corp. as a gasoline additive under the brand name "Ethyl" Ignition Control Compound 4, is also available now in large volume for a number of chemical uses, the company has announced.

Among chemical applications in which the compound shows promise, according to Ethyl, are the following: As a methylating agent, it converts acyclic compounds into methyl ethers, and converts aniline and methylamine into their dimethyl derivatives. As a solvent and synergist, it increases the activity of some insecticides. As a catalyst, it accelerates the "set" of urea-formaldehyde resins. Also, a thin coat of the material will improve the heat stability of other resins.

Among other projected applications; when used as a solvent, it dissolves polyvinylidene cyanide and its copolymers to improve fiber spinning operations. Also, it promotes flame resistance in paint solvents, and it will strip hydrogen cyanide from gas mixtures. Finally, as a suppressor of static electricity, the compound inhibits the static charge created by the rapid release of carbon dioxide from metal containers.

In another recent announcement, Ethyl has reported its new Antioxidant 702, for synthetic and natural rubber and for plastics. The product is already widely used in automotive and aircraft piston engine oils, in railroad and marine diesel engine oils, and industrial oils.

The material is a product of the ortho-alkylation process discovered in the Ethyl laboratories. A sterically hindered phenol of low volatility, it consists of two of the basic molecules (2,6-di-*tert*-butylphenol) linked at the para position through a methylene bridge.

Fuel Cell Research Agreement

An agreement has been signed for the exchange of research information and for future cooperative development of fuel cells by The Electric Storage Battery Co. and Sun Oil Co.

Electric, the nation's oldest producer of packaged power devices, is one of the leaders in the electrochemical field and in the development of electrodes for fuel cells. Sun has conducted an independent research program in catalyst systems used in fuel cells.

ASTM Changes Name

The name of the American Society for Testing Materials was officially changed to the American Society for Testing AND Materials with the signing of a court decree on September 18, 1961, amending the Society's Charter originally granted in 1902 by the Commonwealth of Pennsylvania.

In announcing this change, ASTM President Miles N. Clair said, "The inclusion of the word 'and' in the Society's name places added emphasis on the Society's research work in seeking knowledge of the nature of materials."

Petroleum Plant "technicapability"

that costs less and earns more

Japan Gasoline Co.'s 33 years of continuous petroleum engineering experience have made it a leader in the field. One of 120 major projects, a JGC-designed unifining-platforming unit with a capacity of 10,000 BPSD is now being constructed for Maruzen Oil Co. This is the largest unit of its kind in Japan to be handled by one firm.

JGC's 400 project engineers and 500 draftsmen are qualified to undertake any processing problem, new plant design, or modernization program in the petroleum, petrochemical, and chemical processing fields. From preliminary research and planning board—through procurement, construction, and start-up—to follow-up and after-service, you can trust the thoroughness of our estimates, the quality of our work, the continuing interest of our entire organization.

Mobility, economy, and speed are advantages of JGC's integrated system of operation, and our final products are fully guaranteed. For details write Japan Gasoline Co., Ltd., New Ohtemachi Bldg., Chiyoda-ku, Tokyo.

JGC

Engineers & Constructors

JAPAN GASOLINE CO., LTD.

Process engineering from "on-paper to on-stream"

THE WHOLE RANGE OF FIBREGLASS FLEXIBLE INSULATION

strip, wired-mattress, sewn sheets;
for temperatures up to 1000°F

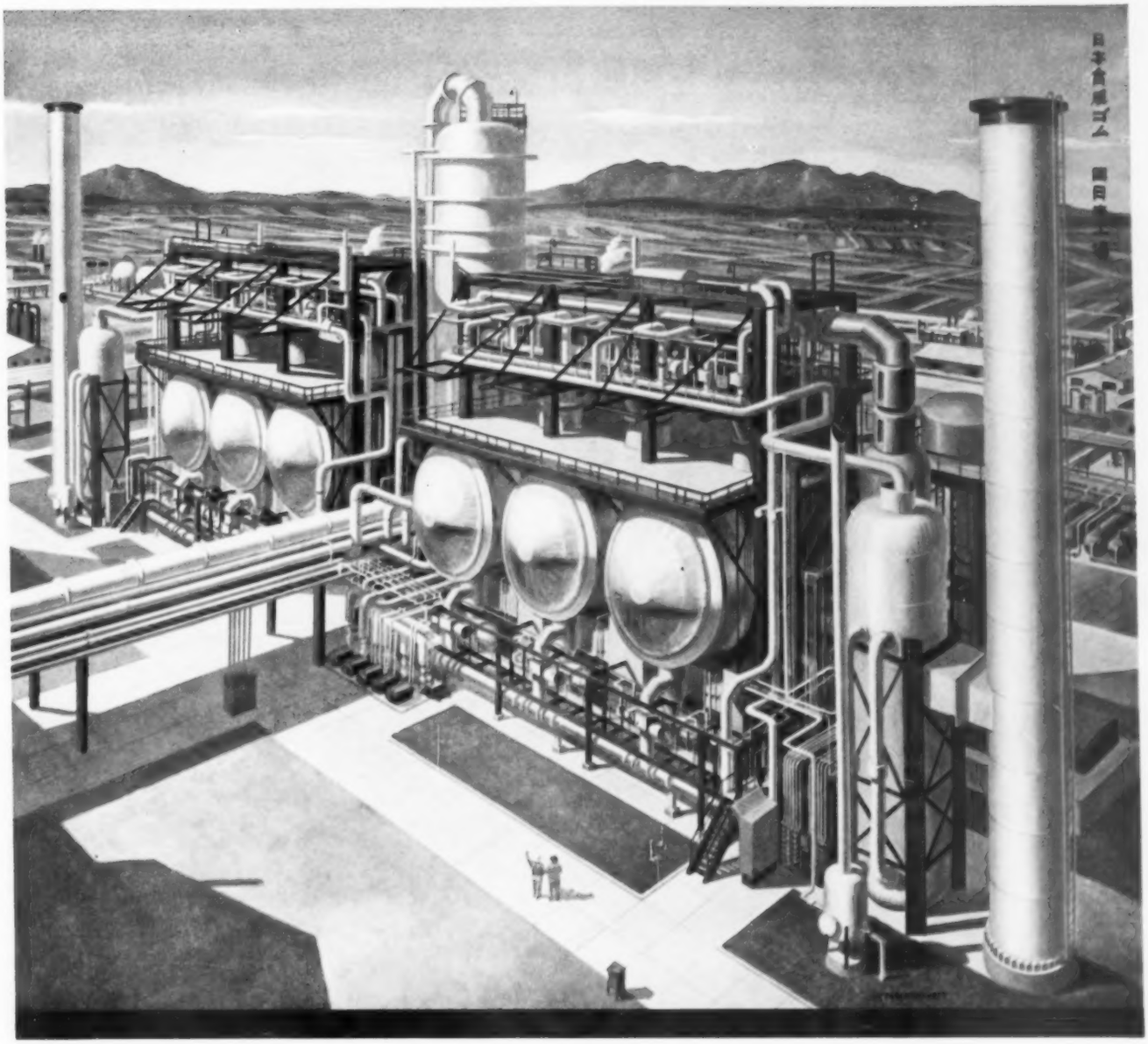
IS NOW MADE IN CROWN FIBRE

Fibreglass CROWN—long fibres; complete freedom from shot and coarse fibres—has the lowest thermal conductivity available in this type of insulation with less than half the weight of competitive products.

This in itself would offer decisive economic advantages . . . But, at the same time, *prices are reduced* on many sizes by as much as 24%.

TWO OTHER DEVELOPMENTS. Fibreglass flexible insulation is now available stitched to scrim or wire netting on one side only. (This form is intended specially for high temperature applications). Wired mattress is available with expanded metal on one side. Full details from:

INSULATION SALES DEVELOPMENT DEPT., FIBREGLASS LTD., ST. HELENS, LANCS.



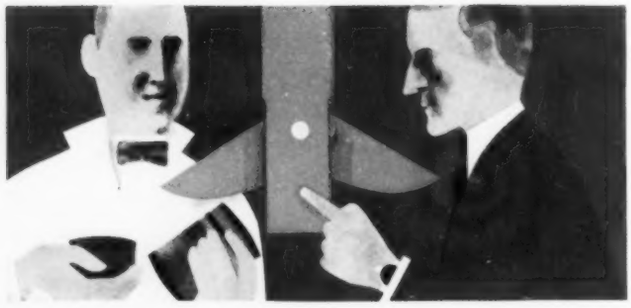
ONE-STEP BUTADIENE PRODUCTION COMES TO JAPAN

Japan Synthetic Rubber Co., Ltd., is now using the flexible, single-step Houdry Dehydrogenation Process. This new plant, at Yokkaichi, Japan, is the first butadiene plant in Asia. It is designed to produce 25,000 ton yr of butadiene from butane, using Houdry Dehydrogenation Catalyst. Feed stock may range from straight run butane to complex mixtures from steam cracking operations. Reactors are arranged in two parallel systems which can be operated independently. Versatility of the process allows easy adaptation to efficient production of butenes and other olefins. A complete process description may be obtained on request, from Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.

*HOUDRY PROCESSES

*Houdry means Progress . . . through Catalysis

NEW UNDERGROUND SUPERHIGHWAY



Read how Gulf's Single-Point Entry Technique for fracturing gives up to 100 times the fracture capacity of conventional fracturing... offers you precision placement and increased drainage, too.

GULF

Perhaps you have used hydraulic fracturing successfully. It has helped many oilmen jump well production to 5 and 6 times the usual bbls./day.

For a dozen years now, the basic technique of pumping fracturing fluids down the well bore under pressure to stimulate the flow of oil has been modified and improved.

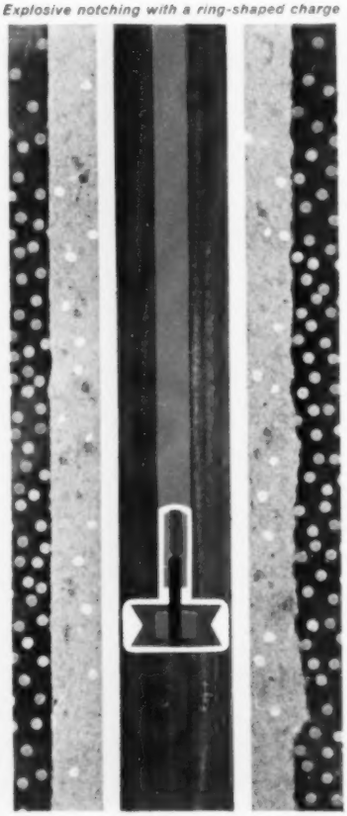
But this conventional fracturing has its limitations. The industry has known this for a long time. At best, it is hit-or-miss. You can end up throwing several thousand dollars down a hole.

More often than not, you may be limiting your profits when your pay zone is thick or of low permeability.

It's also true that fracturing can give you disappointing results in a thin zone if the location of the fractures isn't right.

The scientific answer. Now, out of studies of fracturing at the Gulf Oil Corporation's Harmarville Research Center, comes an altogether new approach. One that all but takes the "miss" out of well stimulation.

Explosive notching with a ring-shaped charge



For Gulf's development isn't just another technique. It is a precision system for fracturing. It replaces great gaps in our knowledge of fracturing with a painstakingly developed and tested body of scientific facts. It brings new ideas, new tools into play.

Our name for this precision system is Single-Point Entry Technique for fracturing.

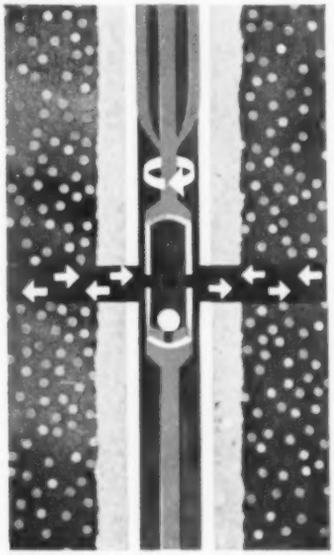
Up to 100 times the fracture capacity. Twenty-four service companies have already become Gulf licensees. In their hands, Single-Point Entry Technique for fracturing has already proved itself to be all our studies showed — and more.

One, it stimulates wells on jobs where conventional fracturing wouldn't even be worth a try. In itself, this characteristic moves

fracturing a long step ahead.

Two, Single-Point Entry Technique for fracturing usually outstimulates conventional fracturing techniques.

In both cases, Gulf's new system gives up to 100 times the fracture capacity of conventional fracturing. It has actually pushed productivity beyond the most hopeful expectations. In some cases, 20, 40, 60 times.



Hydraulic notching with an abrasive fluid

This system gives you all 3. Why does Gulf's new system give so much more than conventional fracturing? Because no conventional technique offers this scientific, systematic, 3-step approach: (1) precision fracture placement, (2) high fracture capacity and (3) an adequate reservoir drainage system.

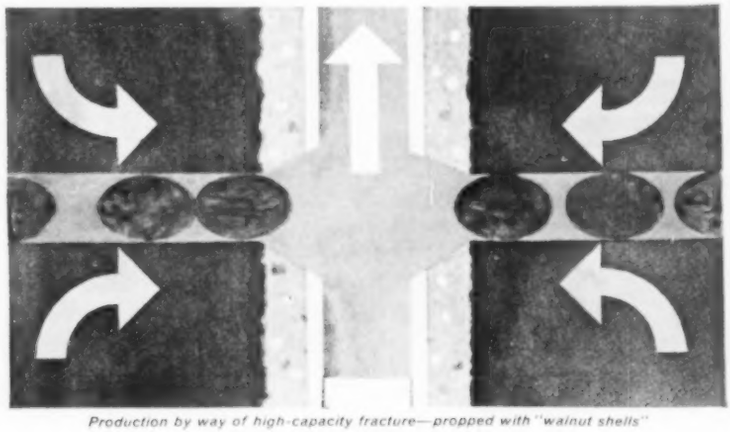
Now Single-Point Entry Technique for fracturing is available to boost your well flow levels. To pay you a sizeable number of bonus benefits as well. To improve reservoir drainage, for one. To lessen pressure drawdown. To lower gas-oil ratios. To minimize water coning. To make work-overs simpler.

"Superhighway" for oil. No more hope-for-the-best fracture location. In Single-Point Entry Technique for fracturing, any one of three tools cuts the notch precisely where reservoir study says it should.

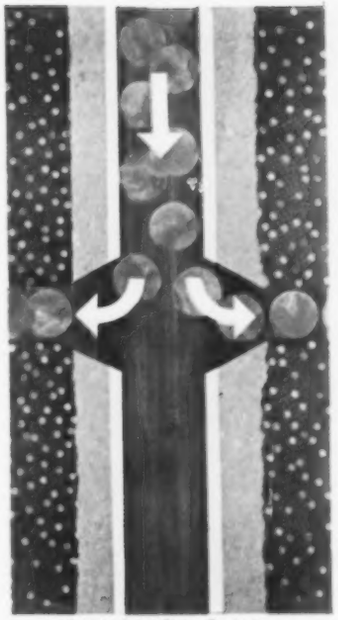
These tools include a mechanical cutter, a hydraulic notcher which jets an abrasive stream, and a ring charge for use in explosive notching.

No more helter-skelter fractures with Single-Point Entry Technique for fracturing. In their place, a single large "superhighway," extended deep into your pay zone.

And no more inadequate drainage. Your large fracture area and carefully prescribed propping agents assure that.



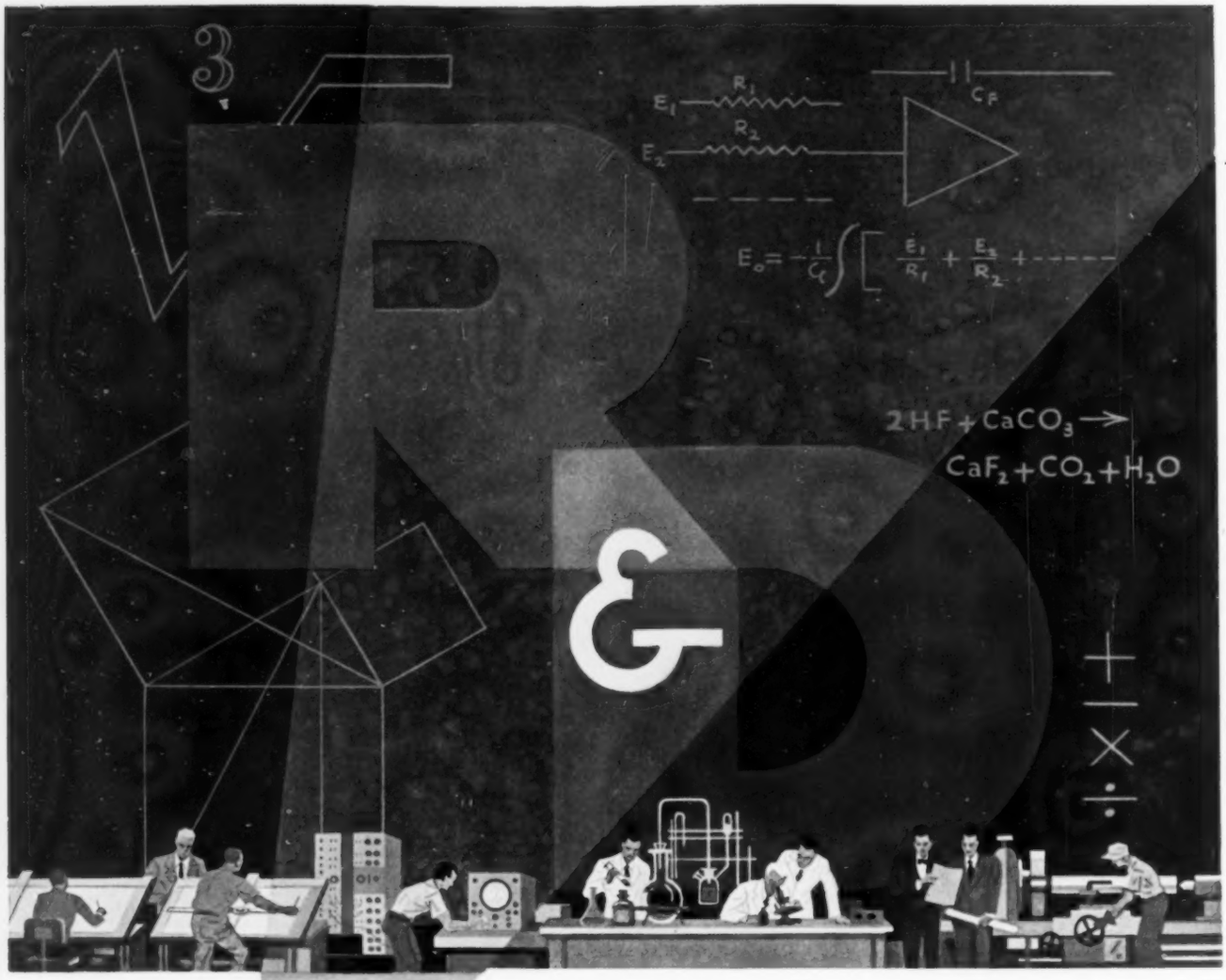
Production by way of high-capacity fracture—propped with "walnut shells"



Single-Point Entry Technique

Just contact these licensees. It's so easy to have the Single-Point Entry Technique for fracturing custom-fitted to your well-stimulation needs. Simply contact any one of these Gulf licensees:

Acid Engineers, Inc. • Acme Tool, Incorporated • Axelson-Garrett Division, U. S. Industries, Inc. • Baash-Ross Division, Joy Manufacturing Company • Baker Oil Tools, Inc. • BJ Service, Inc. • Cardinal Chemical, Inc. • Chemical Sand Services, Inc. • Dowell Division, The Dow Chemical Company • Eline Acid Company (The) • Eskimo Fracturing & Well Servicing Ltd. • GO Oil Well Services, Inc. • GO-Western Service • Grant Oil Tool Company • Halliburton Company • Independent Oil Well Frac Company • Lane-Wells Company • Oklahoma Fracturing Services, Inc. • Producers Chemical Company • Sand Survey, Inc. • Servco Company (The) • Western Company (The) • Wireline, Inc. • Worth Well Surveys, Inc.



GOLD *from the Philosopher's Stone*

In medieval times alchemists searched relentlessly for the mysterious "Philospher's Stone" to acquire its magical power to change ordinary matter into gold.

Unfortunately (or maybe not) the mystic substance was never discovered, but the concentrated search and endless experiments conducted by these secretive ancients is said to be the birthplace of modern chemistry.

Today, the constant search for new truths from new ideas is crisply referred to as "R & D." But unlike the "Philosopher's Stone," modern Research and Development in our industry has turned man's search for oil into profitable enterprises far more valuable than gold.

To be without the benefits of this "black gold" is unimaginable, and Halliburton's comprehensive R & D program is continuing to contribute to its profitable recovery.

Halliburton COMPANY
DUNCAN, OKLAHOMA

NEEDED—
MORE UNDERSTANDING

by M. J. Rathbone
President, Standard Oil Co. (New Jersey)
and Chairman, American Petroleum Institute

These are times when high priority should be given by both business and government to efforts to improve understanding and cooperation.

Businessmen are only too often overly antagonistic to government — and equally, those in government have found it politically useful to harass business. We still describe our system by the term "private enterprise" but it is obvious we now have a mixed public-private economy. And that is the fact upon which we must work. Unless we believe we can turn the clock back, that must be the starting point of any realistic discussion of business and political affairs.

There are no ready-made criteria easily applicable for every situation. We are dealing with a world in revolution. In such a condition we need flexibility; we need realism. What is the problem and what is the best solution of it? These are the questions we should ask ourselves, and we must find the best solution using all the means, public and private, that lie at our disposal.

Such an approach has already proved abundantly fruitful. Look at the defense program. Here urgent national needs have generated a vast private industrial and governmental complex, producing research, weapons, equipment and supplies in great amounts and of great complexity. Our missile program and our space program are a joint government-business project which brings the energy and initiative of private enterprise into the service of national and international goals.

Our primary problems are now global in scope. They are altogether too vast for government or business corporations to resolve alone. To meet the demands of the cold war, clearly a working partnership between business and labor and government is needed.

The Soviet Union is strong, it is well-organized, it has a single purpose, and its resources are skillfully used. How possibly can we compete with them unless we have such a partnership similarly dedicated to well understood goals and similarly armed with a comprehensive strategy?

I am not advocating any submission by business, either individually or collectively, to principles it feels are basically unsound. Nor am I saying that to cooperate business should remain silent in the face of unwise or unjust government actions. Our basic freedoms would not last long in such a climate. But clearly, if we are to avoid the extension of government authority, we must propose and vigorously push better means of getting the job done.

I know from experience that working with government is no bed of roses. Our industry has had occasion many times to oppose governmental policies, and to deplore what appeared to us a lack of understanding of our business. Again and again the same issues arise and our store of patience becomes sorely depleted. But in justice we must admit there are usually two sides to every question. Government too has its problems; politicians have theirs. What is needed is a real effort of each party to understand the problems of the other. So business and government must make that effort and then, patiently, firmly and thoughtfully, work out joint solutions. This cooperative approach to solving our nation's problems is, however, no one-way street. Government must cooperate as much as business. Distrust and suspicion, petty political harassment, unwarranted attacks, and the belief that bigness is badness, can have no place in our government's share of the cooperative approach.

In many areas of public policy, business and government must be and are both involved. These include maintaining steady employment, promoting economic growth, stimulating research and development, aiding economic advance in under-developed countries while maintaining the freedom of the individual, and providing efficiently and resourcefully for our vital military needs. Are these not the primary goals of the nation? They are also, I suggest, those of business, as well as of government.

In the past twenty years our industry—and others—have gone through what has been called a big change. The next big change is now upon us. We may be stewards of private business but the hard facts of today's international life have made us participants in public affairs. Let us then, above all, be constructive participants. Vast forces of transformation are loose in the world. We must act constructively and flexibly or they will run their course without us and most probably against us. The opportunity is here now. Once gone it may never return.

The pricing of crude oil

Oil prices are of interest not only to people in the petroleum business but to consumers and to governments of countries where oil production provides a large part of national revenue. Yet relatively little has been written on the subject, and most of that by persons outside the industry and therefore without first-hand knowledge. During the summer of 1961 the editor of *World Petroleum* heard that Standard Oil Company (New Jersey) had prepared, as background information for its affiliates, a paper discussing the economic forces that form crude oil prices. Although intended for internal circulation, to broaden knowledge among personnel, permission was granted us to publish the paper. It is here presented verbatim; only photographs and headings of the several sections, in heavy type, have been added

THE PRICE OF any commodity is a resolution of many factors. Among them are:
(1) The seller's costs, including raw materials and supplies required in turning out and marketing his goods; labor, transportation, taxes;
(2) Competition, not only actual but potential, not only from sellers of the same kind of goods but from sellers of alternative goods;
(3) Value to the buyer, not only in absolute utility but in esthetic or other satisfactions;
(4) Political factors such as government limitation of output, import or export; price-control or subsidy;
(5) The customers' ability to pay, and general economic conditions.

Still further factors may be the proportion of plant being used, desire to keep a skilled work-force intact, possibility of expanding the total market or a particular seller's share of it, effort of a seller to enter a new market area.

In a free market economy, sellers will try to obtain a price that in their judgment will give them the best total profit over the long term. In making this determination, considerations of potential competition, public relations, and possible political reaction will, among other things, act as moderating forces.

Consumers in the aggregate, through their individual decisions as to how to apportion their outlays, exert great influence upon prices and price-relationships. Even with a necessity such as food, there is ordinarily a range of consumer choice or denial. For example, if meat is reasonable in price, consumers in the aggregate will eat a lot of it. If it is dear relative to other foods, they will eat less meat and turn more of their expenditures to dairy and grain products. Because a consumer's decision to buy one thing is also in effect a decision not to buy something else that could be got with the same money—in other words, a weighing of *relative* values—it follows that any price in a given market, which may be worldwide, bears some relationship to the pattern of prices in general.

Early Days: Thus when petroleum became a fairly widespread article of commerce in the mid 19th Century, its sellers did not have an infinite range of choice as to the price at which they would offer their goods. The principal use for petroleum at the time was as an illuminant, and the refiners who distilled lamp-fuel from crude oil had to sell their product in competition with whale oil, coal oil, and tallow candles. Also, they had to sell against a background of an established concept as to what lamp-oil was worth. There were, in other words, certain reference points for the value of lamp-oil, and this fact, in turn, set a ceiling on the price of the raw material from which it was made.

Before the successful completion of Edwin Drake's well in 1859, crude oil was obtained by skimming seepages of it from ponds or from pits dug for its accumulation, and its price was around $20 per barrel. At that price, there was incentive for people to drill wells which, if successful, would produce much more crude than could be got by the skimming method. With many enterprisers looking for petroleum, much was discovered, and the price of crude oil declined within a short time to $1 per barrel. The price of lamp-oil likewise fell, with the result that millions of people who could not previously afford lamplight now enjoyed it.

Besides being the source of kerosene for lighting and cooking, crude oil was—in the early days of petroleum as now—the source of lubricants, heavy fuel oil for industry, and a number of other items. For many years, though, kerosene was the chief product. Then, as automobiles began to be mass produced, gasoline grew in importance and, about 1915, passed kerosene in volume of output. Even with this change in the relative volume of products made from crude oil, however, the price of crude did not alter much from that which had been established by earlier market forces. There was change, though, in the pattern of prices for products. Gasoline, which had had limited utility earlier, rose in price as demand for it soared, and the price of kerosene declined.

Oil's Nature: The price of crude oil is profoundly affected by characteristics more or less peculiar to the material. In the first place, although oil is being discovered in more and more parts of the world, not all places are geologically favorable for its occurrence. Yet its products are used worldwide, so it has long been, quite naturally, an item of international trade. Oil is, in fact, the chief commodity in point of tonnage and value carried by the world's merchant fleets, and transportation is often an important element in oil pricing.

Second, oil is expensive to store. It cannot be piled on the ground like lumber, coal, or ore, and tanks built to hold it are rather elaborate structures. The best place to store oil is in its natural reservoir in the earth, and the amount of it in above-ground storage at any one time, while very large, is equivalent to market requirements of only a few weeks or months.

Third, oil must be kept moving. Because of the vast quantities of it used daily, and because of the relatively limited storage possibilities in terms of days' supply, a figurative "oil pipeline" stretching from producing fields to markets must be kept constantly filled. This "pipeline" consists

To produce revenue, oil must be sold—often far from where it has been produced. Sales of oil are usually made f.o.b. the port of shipment, with the purchaser himself arranging and paying for transportation. Here the supertanker "Esso Zurich" moves through long sea-swells toward New York

of highly specialized equipment developed by the oil industry—pipelines, tankers, refineries, oil barges, tank trucks, tank cars. A substantial break in any part of this long line can produce near-emergency conditions calling for massive rearrangements in the intricate pattern of distribution that has been built up over many years. The closure of the Suez Canal in 1956 provides illustration of such a necessity.

Fourth, oil is a natural resource, and any particular deposit of it is exhaustible. Once the oil in a field has been withdrawn, you cannot "grow" more of it there as new crops can be grown on the same agricultural field, and you cannot manufacture it as new automobiles can be turned out year-after-year in the same factory. Oilmen, therefore, must continually *find* new oil, not only to replace that which is used but to provide reserves to meet growing requirements.

Hunting for new oil, however, is an unpredictable undertaking. Unlike a manufacturing business, where the costs of making a product can be fairly well estimated in advance and will probably be about the same for one enterpriser as for another in a given location, the costs of finding new oil vary widely. One searcher may put down dozens of holes, spend millions of dollars, and find nothing. Another may make a strike with his first trial. Further, there can be great differences even with respect to successful ventures. One discovery may be of a very large structure, with conditions making for high-flow wells. In such a case, unit cost of the oil will be relatively low. Another discovery may be much less prolific, so that unit costs are proportionately higher.

Fifth, the time-spans involved in the oil business are long. Even after a new field is discovered, its development may take years. Following the drilling of a successful well, efforts will be made to delineate the structure by a series of step-out wells. Then, if the structure proves of commercial size, tankage and pipelines will be built. In remote areas, it may be necessary to construct many ancillary facilities—housing, roads, workshops; perhaps docks, jetties, and airfields; possibly hospitals and schools. All of this is, of course, both costly and time-consuming, so a long period usually elapses between discovery of a new field and the arrival at market of the first barrel of oil drawn from it. Thus financial and operational planning must be on an exceptionally long forward scale.

No Single Price: It is possible to speak of *the* price of crude oil only in the broadest way. Actually, there is not one price at a given time but many. Crudes vary widely in their properties, and a crude of particular kind, perhaps a very heavy grade, may remain unchanged in price while prices of lighter varieties are rising; or its price may even move in the opposite direction. Location also affects price. A crude produced in a field far from important consuming centers will bring a lower price at the well or shipping port than a similar grade from a more accessible source because it costs more to bring the former to market.

Over the years there developed in the oil industry in the United States a practice of *posted* prices. This simply means that any refiner or agent wanting crude oil *posts* a price at which he is willing to buy oil from a specified field, from any operators in that field, who may number in the dozens.

In general, ownership of land in the United States and Canada includes the subsurface and any minerals it may contain. In the United States there are something over 12,000 crude oil producers, most of whom do not have refineries and do not sell finished products but are solely in the crude-producing end of the business. Besides this number of producers or "operators," there are many more thousands of royalty-owners who have a proprietary interest in the oil that is sold. Although each producer usually sells his oil over a long period to a single purchaser (who has probably laid a gathering pipeline to connect the wells with a trunk pipeline), he is not irrevocably tied to that purchaser, and if he should become dissatisfied with the price he was receiving, he would have the right to dispose of his oil to someone else.

The largest purchasers of crude are, by and large, the "integrated" companies that engage in all branches of the oil business. Whereas these companies produce crude themselves, no more than three or four of them produce enough in the United States to meet their own refinery needs, so most of them, including the largest, must buy from other producers. These companies are also marketers, competing among themselves and with others to maintain or enlarge their shares of retail trade. It follows that if one of them cut the posted price it was willing to pay for crude—and "missed the boat" in the sense that its competitors were willing to pay more—it would soon find that it was short of products to sell and that its market position was being lost. This economic "fact of life" constitutes a brake on downward crude price movements.

There are brakes, too, on the upside. What is probably the chief of these results from the fact that there are economic ceilings on the prices of products made from crude oil, hence on the raw material. For example, if the price of heavy fuel oil got too far above that of coal, the former would lose market position to the latter; the price of home heating oil cannot get

Although oil is being discovered in more and more parts of the world, not all places are geologically favorable for its occurrence. Yet its products are used worldwide, so it has long been an item of international commerce. Here tankers take on cargoes at the Amuay refinery in Venezuela

out of line with that for natural gas; and, even though the demand for motor gasoline is ordinarily described as "inelastic," an undue rise in its price would undoubtedly influence driving habits so that a higher price might well produce lower revenue through reduction in volume of sales. An additional, although not so immediate, consideration is that, at some level of crude oil price, it would become attractive to begin deriving liquid fuels from oil-shale.

From the beginning of the oil industry, the United States has been the world's largest petroleum consumer. It has also been, except for two or three years around the turn of the century, the largest single oil-producing nation. And until 1931 it was the chief oil-exporting country. (Until the 1930's, in fact, the only other important oil exporters were Russia, from about 1885 to World War I, and Mexico at the time of World War I and for a few years thereafter.) As a consequence, "U.S. Gulf prices" —that is, prices at the U.S. coast of the Gulf of Mexico, from which great quantities of oil were shipped both to the U.S. East Coast and into world markets—came to be regarded as the reference point for oil prices generally throughout the world.

In the late 1920's, oil from Venezuela began to flow increasingly into world markets and, by 1931, that country's oil exports surpassed those of the United States. However, since this new source of exports was about the same distance from principal markets as was the U.S. Gulf Coast, and since the latter still remained a large source, U.S. Gulf prices continued to be the most important reference in virtually all world markets. Not only was this an expression of the importance of the Caribbean-Gulf Basin as a point of supply, but the quotations provided a convenient, widely published set of trade figures. In recent years though, Venezuelan prices have moved quite independently from those in the U.S. Gulf.

With the great rise in oil production in the Middle East, largely after World War II, another natural reference point arose. In 1950 Socony Mobil instituted the posting of prices at which it would sell crude oil in the Middle East, and the practice was soon adopted by other companies operating in the area.[1]

"Natural" Markets: Circumstances of geography and transportation make for certain "natural" or "tributary" markets for oil from a particular source. Where these markets border upon one another there are what might be called "watersheds"—points on one side of which it is cheaper for a buyer to get his oil from a source on that side than from a source on the other. These "watersheds" shift in location, depending upon relative quantities of exportable oil pressing for outlet from one source as compared with another, easy or tight availability of shipping with consequent effect upon freight rates, and other factors. In this connection it should be noted that sales of oil, whether crude or refined products, are customarily made at prices f.o.b. the ports of shipment, with the purchaser himself arranging and paying for transportation. This practice is one of the reasons that freight rates are usually a significant component of the laid-down cost of oil in a market and why the "watersheds" may shift with changes in freight rates.

Because oil moves so widely in world commerce, the prices in one market quite naturally will bear some relation to those in others. The heavily industrialized nations of Western Europe, for example, import oil from several countries in the Eastern Hemisphere and from a few in the Western; and if the oil from one of these sources were priced higher than that from another (assuming equivalent quality and taking into account shipping costs), the higher-priced would tend to get shut out. But within a given market, internal forces of supply and demand and of competition also exert great influence. Actual or poten-

TABLE I—EXPORTS OF CRUDE OIL AND PRODUCTS FROM UNITED STATES, VENEZUELA, AND MIDDLE EAST 1938-1960

YEAR	UNITED STATES	VENEZUELA	MIDDLE EAST	TOTAL*
		— THOUSANDS OF BARRELS DAILY —		
1938	532	508	245	1,285
1946	420	1,029	542	1,991
1951	422	1,617	1,703	3,742
1956	430	2,317	3,107	5,854
1958	276	2,437	3,843	6,556
1959	211	2,571	4,119	6,901
1960	202	2,675**	4,725**	7,602**
		— PER CENT OF TOTAL —		
1938	41	40	19	100
1946	21	52	27	100
1951	11	43	46	100
1956	7	40	53	100
1958	4	37	59	100
1959	3	37	60	100
1960	3	35	62	100

* This represents upwards of 80 per cent of all crude oil and oil products moving in international trade.
** Preliminary.

[1] See Tables I and II.

tial competition from alternative sources sets a ceiling, but under that ceiling a seller will try to get the best price that conditions within the market permit. Thus prices of crude reflect both economic forces *within* a market and the prices of crude in *other* markets, with the latter being in turn determined by combinations of similar influences.

Shifting Sources: Up to about 1932 the oil needs of Western Europe (the largest area of consumption outside the United States) were met by exports from the United States, largely in the form of finished products. Then Venezuela became the chief source of European supply until about 1948. At that time, increasingly large reserves of oil were being developed in the Middle East and were seeking outlet. Middle Eastern crude began to displace oil from Venezuela, and today most of Europe's oil by far comes from the Middle East. Another change in the pattern of European oil supply has followed from the fact that, over the past several years, refining capacity in Europe has been greatly expanded. As a result, oil imports, which have grown tremendously, have shifted in large measure from finished products to crude.

At intervals, consumers in Western Europe have complained that the price of crude oil laid down in their countries is too high because, they maintain, the Middle East price is "tied" to prices in the Caribbean-Gulf of Mexico area, where crude oil bears a higher cost of production. Contrariwise, governments in the Middle East have complained that the posted price is too low because it is "tied" to Western Hemisphere prices, *minus* the freight-cost that would be necessary to bring Middle East oil into the Western Hemisphere market; they say that the freight-discount is artificially excessive inasmuch as Middle East oil actually moves chiefly to Europe rather than to the United States.

In point of actual fact, neither of these suppositions is correct, and the marketing of Middle East oil in Europe reflects chiefly the circumstances particular to itself. A ceiling is put on the laid-down cost by actual or potential competition from alternative supplies—crude from North Africa or the Western Hemisphere, refined products imported into Europe from the latter source, or coal. Other competitive factors include the possibility of transporting natural gas from the Sahara across the Mediterranean and the emergence of the Soviet bloc as an exporter of oil for political as well as economic reasons.[2]

On the other hand, the posted price of Middle East oil is kept from getting unrealistically low by two factors. The first is that some of the Middle Eastern governments have royalties which, if they choose, they can take in kind—that is, in the form of oil rather than cash—and if there were buyers willing to pay more than the posted price, these governments could themselves sell this oil, thus demonstrating its actual market value. The second factor is the self-interest of the operating companies in the Middle East; from normal commercial motives they want to realize as much as they can from their sales.

Quality and Price: Reference has been made in these pages to the factor of crude oil quality, and it is worth noting briefly its influence upon price. This influence derives from the different volumes of products that can be obtained from different crudes. In the United States, for example, with its very large number of motor vehicles and oil-heated homes, there is high demand for gasoline and light oils. Fortunately, many of the indigenous crudes are of a light variety which gives relatively high gasoline yields. American refineries, moreover, have been designed to maximize the amount of gasoline obtained from each barrel of crude that is processed. Over 40% of total refinery output in the United States is gasoline; only 12% is heavy fuel oil. In Europe, on the other hand, with a relatively much smaller number of motor vehicles and homes with oil heat, the pattern of demand is quite different—refinery output is about 20% gasoline and 40% heavy fuel.

It follows that the U.S. refiner gets more money for the products he makes from a barrel of crude oil than a refiner in Europe can get for what he turns out. So American crudes can fetch higher prices on the American market than, say, Middle Eastern crudes on the European market. Also pertinent in this connection is the fact that the United States government, from motives of domestic policy, has set import quotas on crude oil and petroleum products.

Oil Search Goes On: The crude oil that is being produced today may have been discovered twenty or more years ago or relatively recently. It may have been found after long and expensive search or as the result of a lucky strike. Regardless of these circumstances, the price at which it can be sold is governed by today's market conditions. At a given price for crude, the individual or company with oil that cost little to find makes more money of course than one whose original finding costs were higher.

As has been said, however, the oil in any particular deposit is exhaustible—it dwindles with every barrel drawn from the wells. If an oil company is to stay in business, therefore, it must find new deposits containing as much recoverable oil as it sells. If the company is to grow, it must find even more oil than it currently sells. This is but another way of saying that, just to try to remain in business, a company must derive from its revenues today enough money to explore for oil for tomorrow.

It may be asked why oilmen go on searching for oil even at times when there may be very adequate or even overabundant potential production relative to current demand. One reason, of course, is that any oil company which plans to stay in business must think not only of present demand but of future requirements. In addition, there are a variety of other reasons, which will have varying weights with different companies depending on each one's circumstances. A company, for example, may explore in a particular country, not primarily to find oil in quantity

TABLE II—REPRESENTATIVE CRUDE OIL PRICES

(PER BARREL)

	WEST TEXAS* 32° SOUR	TIA JUANA 26° MEDIUM	34° ARABIAN AT RAS TANURA	SIDON
January 1, 1948	$2.36	$2.40	$ —	$ —
January 10, 1949	—	2.35	—	—
January 13, 1949	—	2.30	—	—
May 22, 1952	—	2.20	—	—
February 5, 1953	—	—	1.71	2.25
June 15, 1953	2.61	—	—	—
June 23, 1953	—	2.30	—	—
July 17, 1953	—	—	—	2.35
July 27, 1953	—	—	1.93	—
February 9, 1956	—	—	—	2.42
December 1, 1956	—	—	—	2.65
December 27, 1956	—	2.40	—	—
January 3, 1957	2.86	—	—	—
January 15, 1957	—	2.55	—	—
June 7, 1957	—	—	2.08	—
September 10, 1957	—	—	—	2.55
February 1, 1958	—	—	—	2.45
February 4, 1959	2.71	—	—	—
February 6, 1959	—	2.40	—	—
February 13, 1959	—	—	1.90	2.27
April 4, 1959	—	2.30	—	—
August 9, 1960	—	—	1.76	2.13
September 14, 1960	—	—	1.80	2.17

* West Texas crude oil price is at the well. Add 31 cents for gathering and transportation to U.S. Gulf Coast refineries and export terminals. Foreign crude oil prices are f.o.b. shipping port. (— represents "no change.")

[2] It might be argued that an oil company or a producing country would realize more by ignoring this potential competition and trying to get a particular price for its crude oil even if it thereby lost a small part of its market. The trouble with this argument is that the amount of market that was lost would keep on growing and, once gone, no subsequent price decrease could retrieve it. High prices that appear to be a permanent policy of the seller are an open invitation to other oil companies, gas companies, and coal companies, and to nuclear energy competition and to the Soviet bloc.

A company must derive from its revenues today enough money to explore for oil for tomorrow. Photo shows member of a geological survey party in Wyoming

that would permit export, but in the hope of improving its competitive position in the country if oil should be found. Also, even though a number of companies may have greater reserves than they need currently, this will not be true of some other companies, and these will keep on looking for additional supplies. Even a company that has a large position in a region which has become a major oil-source may look elsewhere in the hope of finding oil that is even lower in cost or more favorably situated with respect to important markets.

Nations that are importers of oil have a strong interest themselves (conservation of foreign exchange and national security) in the finding of indigenous petroleum and may offer special inducements to searching for it. The constant competition among oil companies makes any of them that has producing interests anxious lest another find a new oil region in which it would not have a stake. And finally, it is good "insurance" for a company management, as steward of the funds of thousands or tens of thousands of shareholders, to diversify its crude sources in order to have flexibility for meeting possible emergencies.

Why Prices Change: If the price of crude oil represents the working out of economic forces, stretching back to the very beginning of the industry, a question naturally to be asked is: What are the main forces that bring about variations?

Put in the briefest form, the answer is —the interplay of supply (or potential supply) and demand. If demand for oil falls off, owing, say, to a decline in general business activity, or if there is a rather sudden and marked increase in crude availability, there will be areas in the world where oil fields are being produced at less than maximum efficient rates. And if this condition continues for a significant while, and especially if there are many such areas, there will be oil that is "looking for a home."

Producers have a great deal of capital tied up in their fields and wells. They also have expenses that continue whether they are producing at maximum efficient rates or not—maintenance, at least a minimum work-force, probably interest on borrowed funds and periodic amortization payments. Especially those whose business is wholly or chiefly in the crude-oil end of the industry will be under mounting financial pressure to turn more of their oil into money. So here and there some of them will be willing to sell at less than the prevailing posted prices. Similarly, newcomers wanting to enter a market where others are already well established may offer oil below existing postings.

If such conditions become widespread and persist, the posted price becomes unrealistic; it is no longer the true "going" price. In due course, probably by a series of trial-and-error moves, postings should fall to a point reflecting actual conditions—and indeed must do so if commerce is to proceed in orderly fashion.

Conversely, when demand is strong and refiners and brokers are eagerly bidding for crude oil to be converted into products for consumers, postings will tend to rise. Sometimes a company, misreading the market, will change its postings up or down, and then find that conditions are not what it supposed. In such case, the new higher or lower price will not "stick," and the company will have to go back to the previous price or to some point nearer to it.

In addition to these market influences, oil companies engaged in international trade are subject to other pressures. The countries in which they do business have differing interests—some are large exporters of crude who may obtain a great share of their governmental revenues from oil.[3] Some import crude but also export refined products; some import all their refined products; and some import a combination of crude and products. Countries that export crude oil naturally prefer to see crude oil prices higher rather than lower. Oil importing nations, just as understandably, want to buy oil as cheaply as possible.

Crude oil prices emerge as a pragmatic resolution of such forces—out of the self-interest of nations, the balance or imbalance at a given time of supply of oil and demand for it, competition among producing areas, competition within the oil industry itself, actual or potential competition from alternative fuels, costs of labor and materials, the level of taxes, and the many other factors that affect economic life generally.

TABLE III
DIRECT PAYMENTS BY OIL COMPANIES
TO GOVERNMENTS OF MAJOR OIL PRODUCING COUNTRIES*
(Millions of Dollars)

YEAR	VENEZUELA	IRAN	IRAQ	KUWAIT	SAUDI ARABIA
1954	$ 485	$ 9	$191	$194	$281
1955	555	91	206	282	275
1956	983	153	193	293	283
1957	1,237	213	144	308	303
1958	863	272	237	354	302
1959	1,044	258	252	345	315

SOURCES: Venezuelan data from Banco Central de Venezuela—Annual issues of "Memoria." Middle East data from paper, "Energy for Economic Development," p. 5, John L. Ivers and Edward Symonds, presented at Second Arab Petroleum Congress, Beirut, Lebanon, October 19, 1960.

* These do not include import duties, exchange payments, and other such indirect revenue.

[3] See Table III.

will meet in Chicago

41st annual conference of the American Petroleum Institute features speakers from government, industry, and business

UNITED STATES SENATOR A. S. Mike Monroney of Oklahoma and Assistant Secretary of the Interior John M. Kelly are among the featured speakers who will address an estimated 6,500 petroleum industry men from throughout the nation and abroad at the 41st annual meeting of the American Petroleum Institute in Chicago November 13-15.

Several other leaders from the fields of government, business, industry, and education will also present talks at sessions at the headquarters hotel, the Conrad Hilton, and at the Pick-Congress and the Palmer House.

Among them are George P. Baker, president, Transportation Association of America; George S. Benson, president, Harding College; Dr. Robert J. Anderson, assistant Surgeon General of the U. S. Public Health Service; George P. Larrick, commissioner of Food and Drugs, U. S. Department of Health, Education and Welfare; Martin R. Gainsbrugh, chief economist, National Industrial Conference Board; and Allison R. Maxwell Jr., president, Pittsburgh Steel Co.

Senator Monroney will address the opening general session of the meeting on Monday, Nov. 13. Also speaking at this session will be: Frank M. Porter, president of the API, and William F. Kenney, chairman of the API Committee on Public Affairs and vice president and general counsel of Shell Oil Co., New York. M. J. Rathbone, chairman of the API Board of Directors and president of the Standard Oil Co. (New Jersey) will preside.

Assistant Secretary Kelly and Mr. Rathbone are scheduled to deliver addresses at the second general session Wednesday, Nov. 15.

In addition to the two general sessions, nine group sessions on specific subjects have been scheduled for the Chicago meeting, plus almost 150 individual committee meetings, many of which will be taking place during the several days preceding the opening as well as during the entire meeting. Meetings of the API Board of Directors will take place Nov. 14 and 15; and Board committee meetings are scheduled throughout the three-day program.

Details on the individual group sessions of the various divisions follow.

The Division of Production's group session will be Tuesday afternoon, Nov. 14, with Gage Lund, the API vice president for production and vice president of Standard Oil Co. of California, presiding.

Speakers include: George Benson of Harding College, Searcy, Ark., who will discuss "Selling America's Economic System to Americans;" James A. Clark, public relations consultant of Houston, Texas, on "The PR Potential in Production;" and Lester T. Potter, president of Lone Star Gas Co., Dallas, Texas, on "Cooperation on Natural Gas Bill Finally Achieved."

The Division of Refining's group session on Tuesday, Nov. 14, will be presided by A. P. Frame, vice president for refining of the API, and senior vice president of Cities Service Co., New York. A paper "Refining or Petrochemicals: Which Will Win?" will be presented by Henry G. McGrath and Luther R. Hill of The M. W. Kellogg Co., New York.

The Marketing Division's session will begin with a luncheon on Tuesday, Nov. 14, with V. A. Bellman, API vice president for marketing, and vice president for marketing, Mobil Oil Co., New York, presiding.

The Division of Transportation's group session on Monday, Nov. 13 will be presided by Henderson Supplee, Jr., API vice president for transportation, and president of the Atlantic Refining Co., Philadelphia. Speakers will include: George Baker of the TCA; A. L. Nickerson, president, Socony Mobil Oil Co., New York; and James M. Landis, member of the New York law firm of Landis, Feldman, Reilly and Akers.

A group session of the Division of Finance and Accounting will take place on Monday, Nov. 13. The API vice president for finance and accounting, A. O. Savage, who is comptroller of Standard Oil Co. (New Jersey), will preside. The speaker had not been announced at the time of this writing.

A full program on medical and health and another on electrostatics in petroleum handling have been arranged as group sessions for the API department of Technical Services.

Charles E. Spahr, chairman of the API Medical and Health Committee, and president of Standard Oil Co. (Ohio), Cleveland, will preside at the Monday, Nov. 13, session.

Speakers, and their subjects, are as follows: J. W. Osborn, M.D., medical director of Sohio and chairman of the API Medical Advisory Committee, "Medical Advisory Committee Activities;" Robert J. Anderson, M.D., Assistant U. S. Surgeon General, Washington, D. C., "Environmental Health in the Coming Decade;" George P. Larrick, U. S. Commissioner of Food and Drugs, Washington, "Operation of the Food and Drug Administration;" and H. W. Gerarde, M.D., medical research division, Esso Research and Engineering Co., Linden, N. J., and Dorothy F. Gerarde, Westfield, N. J., "The Ubiquitous Hydrocarbons."

The session on electrostatics also on Monday, Nov. 13, will have W. J. Sweeney, vice president of Esso Research and Engineering Co. presiding.

Speakers include: H. E. Hoelscher and Jerome Gavis, department of chemical engineering, The Johns Hopkins University, Baltimore, Md., "Electrification of Hydrocarbon Fuels;" D. N. Harris, Shell Oil Co., New York, Glenn Karel, General Dynamics Corp., San Diego, Calif., and A. L. Ludwig, Shell, San Francisco, Cal., "CRC Mock-up Tests for Fueling Aircraft Tanks."

Also, R. E. Herzog, Atlantic Refining Co., Philadelphia, E. C. Ballard, du Pont, Wilmington, Del., and H. A. Hartung, consultant, West Collingswood, N. J., "Evaluating Electrostatic Hazard during the Loading of Trucks;" and M. P. Holdworth, Shell Tankers Ltd., London, England, J. L. van der Minne, Shell Laboratories, Amsterdam, the Netherlands, and S. J. Vellenga, N.V. de Bataafse Internationale Petroleum Mij, The Hague, "Electrostatic Charging during the White Oil Loading of Tankers."

A group session on petroleum statistics on Tuesday, Nov. 14, will be presided by C. V. Horky, of Pure Oil Co., Palatine, Ill., and chairman of the API Committee on Petroleum Statistics.

Speakers will be: Martin Gainsbrugh of the National Industrial Conference Board, New York, "Economic Models for 1962;" Ira H. Cram, chairman of the executive committee of Continental Oil Co., New York, "Exploration for Natural Gas;" and J. H. Ellender, chief economist, Arabian American Oil Co., New York, "Developing International Markets."

The group session of the petroleum industry buyers will be Tuesday, Nov. 14. Herman C. Cowdery will preside. He is chairman of the Petroleum Industry Buyers Group of the National Association of Purchasing Agents, and assistant purchasing agent for Cities Service Petroleum Co., Bartlesville, Okla. Two addresses to be delivered at this session will be those by Allison R. Maxwell Jr., president, Pittsburgh Steel Co., Pittsburgh, Penna.; and Jack Cox, vice president, Pico Drilling Co., Breckenridge, Texas.

END

Spanish Legion officer leads his patrol across desert near exploration party's campsite (Photos by Robt. Muir)

Oil Search in the Spanish Sahara

The unexplored territories of Spain in Africa are the scene of an intensive oil campaign. Prospects are unknown but much valuable data has now been collected

The Spanish Sahara was provisionally opened to oil prospecting in 1959, and from April through June, short-term geological and geophysical reconnaissance was carried out preparatory to concession bidding later that year. Since April 1960 when work first started on the concessions granted, twelve oil companies have engaged some nine geophysical companies in their exploration programs.

The major oil companies with concessions in the Spanish Sahara are: Union Oil Co., the Gulf Oil Co., Pan-American Oil Co., Tidewater Oil Co., Sun Oil and Champlin Oil (operating jointly), the Atlantic Exploration Co., Phillips Petroleum Co., Richfield Petroleum Co., American Overseas Petroleum Co. and Valdebro Oil Co.

Geophysical companies which have been under contract to the above are: The United Geophysical Company, Compagnie Generale de Geophysique (CGG), Robert H. Ray International Inc., Geoprosco, Western Geophysical Company, Independent Exploration Company, Geophysical Services Inc., and the Instituto Geologico.

The Spanish Sahara extends for 540 miles along the northwest African coastline and is bordered by southern Morocco, Algeria and Mauritania. Though usually referred to as a whole, the country is split east-west by the sizable wadi, Saguia El Hamra, into two regions; Saguia El Hamra to the north, and Rio de Oro to the south.

The whole country is arid desert with very sparse vegetation usually confined to the beds of dry rivers. The first coastal plain region is covered with gravel and sand with limestone exposures. In the northwest, a line of small sand dunes, 165 miles long and several miles wide, runs roughly parallel and close to the coastline. Farther inland the country is broken by wadis and mesas, while toward the eastern border a rough mountainous barrier runs approximately northeast southwest paralleling the igneous shield to the east.

The indigenous people of the Spanish Sahara are Saharauis or Moorish nomads who eke out a precarious living by tending their camel herds and by sowing small crops, rainfall permitting.

The towns of any size are El Aaiun, Villa Cisneros and Smara. These are primarily military garrison towns governed and run, as is the whole country, by the Spanish military forces. Before the advent of oil exploration, very few civilians could be found in the Spanish Sahara.

Most of the oil companies have made Las Palmas, Grand Canary Island, their base of operations and all head offices and warehouses are located in that town. Las Palmas has a large port and all equipment arriving from overseas is usually routed through it, as are personnel.

However, four companies, Amoseas, Tidewater, Gulf and Union, now have permanent camps and several others have space storage in El Aaiun. These act as base camps and distribution centers for field supplies. Previously, El Aaiun offered no amenities to the civilians except by courtesy of the Spanish Army. Several food stores and fuel depots are now operating and a hotel is in the planning stage.

The first crews to arrive were landed out of Las Palmas on either El Aaiun or Villa Cisneros beaches. Shipments of equipment were unloaded onto lighters offshore, towed through the surf (weather permitting) and manhandled to the storage areas. The situation has been somewhat alleviated, however, with the arrival of several beach-landing craft. Not until recently has work commenced on a pier at El Aaiun beach, some twenty miles west of the town.

In the town of El Aaiun, several companies are catering to the requirements of the field crews. Three freight companies, POLCO, Sala, T.R.ASS., provide fleets of trucks capable of hauling equipment from beach to campsite. The country boasts no paved roads and the existing roadways are poorly marked. Previously the army relied on known tracks running from point to point. However, existing roads tend to become a series of tracks up to two miles wide under heavy traffic and navigation is now a major concern to all. Whereas the major tracks once led from one military outpost to another, they now usually lead from camp to camp, or camp to water supply point.

Geophysical field camps vary in size and composition depending on the different methods in operation. Gravity field camps, for the most part, consist of office, shop, power and water trailers, air-conditioned mess huts, with tents for sleeping quarters. Some seismic crews use trailers exclusively. Mobile power units supply electricity for the shop trailers, air conditioners, refrigerators, office use, radio, showers and camp lighting. All camps, of necessity, are readily mobile and can be moved, on reasonable hauls, ready to operate in a different location within twenty-four hours, thereby minimizing the loss of valuable field production time.

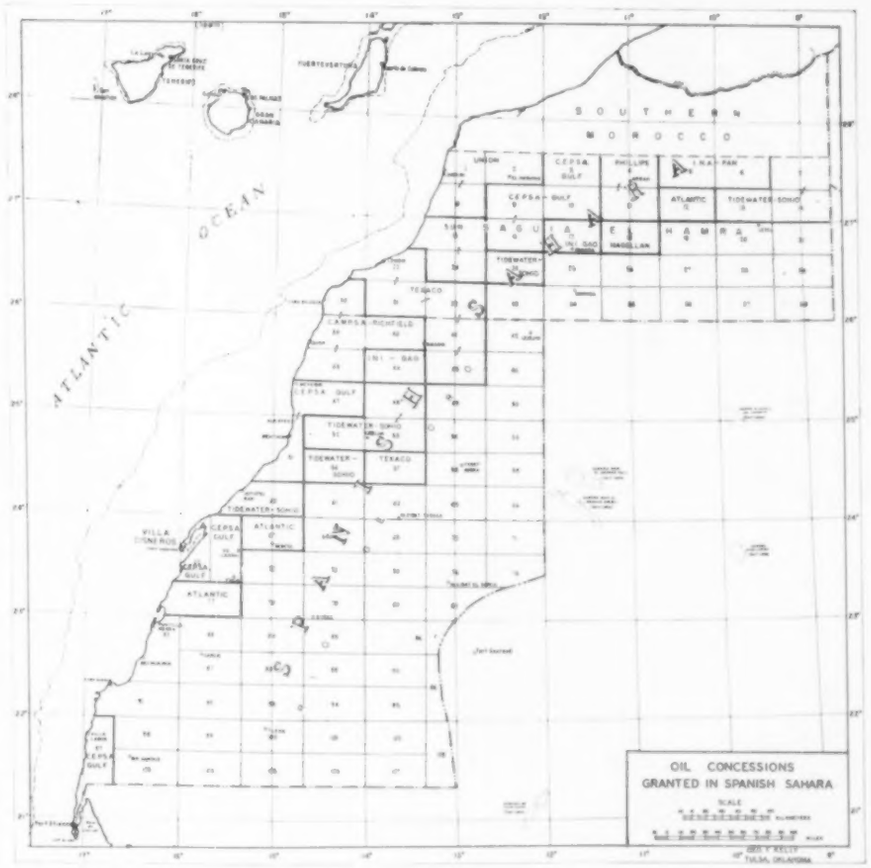
Gravity camps are staffed by about eight expatriates comprising office staff, fieldmen and mechanic. Spanish camp-bosses handle labor and camp supply problems as well as radio traffic, thus relieving party chiefs and managers from administrative duties. Spanish petroleum laws require that all radio equipment be of the single sideband type. Though this restricts traffic to certain frequencies, this equipment is a great improvement over AM or FM units as regards operation and clarity of reception. The law also requires that one wave band be restricted for use between camps and the local military authorities. Each field crew has its own transceiver and apart from general business, these are used in the case of medical emergencies, for air traffic control, and to direct search parties should men become lost. Radio contact between field camps, town offices, and Aaiun police is made twice daily, and in addition, Aaiun police are open for emergency traffic at set times around the clock.

Labor, for both the camp and the field crews, is supplied either by the local Moors, or by Spaniards from the Canary Islands. Twenty or more of the latter are required by each geophysical party, and though demanding higher wages than the Moors, are easier to train. Few of the Moors have had previous experience of skilled work or trades. All expatriates and Spaniards take rest leaves in the Canary Islands.

Weekly supply planes, delivering food perishables, mail and urgently needed supplies, call at each camp where a landing strip is prepared. Three airlines run regular charter flights to the desert from Las Palmas using DC3's or Bristols. Light planes also are available for charter though several of the oil companies fly their own.

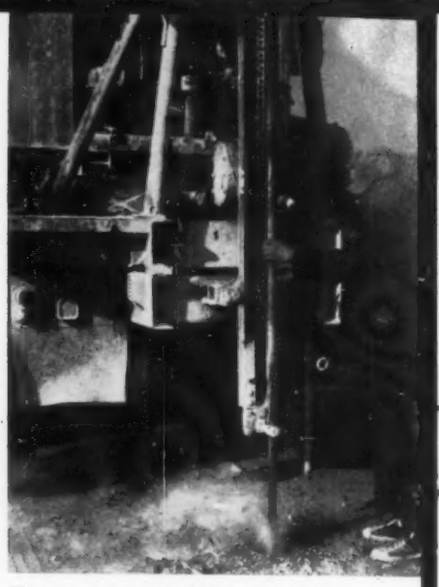
Field parties have differing rest leave schedules, varying from five days after twenty-five days, to seven after twenty-eight (the latter usually reserved for turnkey operations).

Geophone is buried so as to reduce random noise



Portable rig in Spanish Sahara. Lack of water requires use of air in many areas

"Thumper" in action, dropping a three-ton weight



Close-up view of jack-hammer at work. Incessant cold north winds demand heavy clothing

Right: Old tri-motor Junkers plane at AAIUN airfield

Water is very scarce in the Spanish Sahara. The capitol, El Aaiun (The Springs) has the only supply of any note. There, sweet water is drained from a number of ground seeps into two reservoirs. Oases, as such, are not to be found in this desert. Existing wells seem hardly sufficient to support the local nomads. Many wells are slightly salty, and most are over a hundred feet deep. Thus, crews are invariably forced to haul water over long distances from poor sources.

Attempts to find potable water by drilling have so far been unsuccessful. Considerable drilling for water, however, has been going on, and to date, Union has one well, Tidewater one well, and Richfield two wells. The water has been used for washing water as well as for drilling purposes. Fuel supplies are another item requiring long hauls by camp transport as there are just two distribution points: El Aaiun and Villa Cisneros. One Robert H. Ray crew was hauling a full two hundred and fifty miles.

A variety of vehicles have been used for field work, from ¾ ton Power Wagons through Jeeps and Land Rovers. Each has its merits, as there are few rough areas extensive enough to prohibit the use of the smaller vehicles, while they do offer better economy and comfort. However, the larger unit, while having proved its worth on camp moves, has been able to traverse all but the very worst terrain with regular 9.00 x 16 "track-grip" tires. Non-directional track-grip tires will last up to ten months over the worst terrain, where flotation sand tires and steel cord tires last only weeks.

Field crews require a mechanic with three or four assistants to keep field units repaired and maintained. Though the heat is not to be compared with that experienced in southern Libya and the Oman, electric fuel pumps have been found beneficial to motor performance. Blowing dust and sand hampers shop repairs and causes premature motor failures. Because all overhauls are carried out in the field, the constant winds prevalent in this desert sometime make working by day unfeasible. Mechanics then occasionally work at night to assure crews have no downtime. In case of breakdown in the field, units are equipped with emergency water supplies, rations and signal rockets.

Though the Spanish Sahara has been mapped by Spanish Army surveyors, there was very little horizontal and no vertical control previous to the advent of geophysical engineers. Army maps at first seemed surprisingly accurate for such a desolate country. However, most of the recorded astronomical points cannot be properly identified, and for this reason are useless for survey control points. Most geophysical parties have been obliged to run long base lines out to the proposed work areas, before work could commence. One such base line surveyed by Robert H. Ray crews runs from El Aaiun 250 miles to block 7 in the far north-east corner of the country.

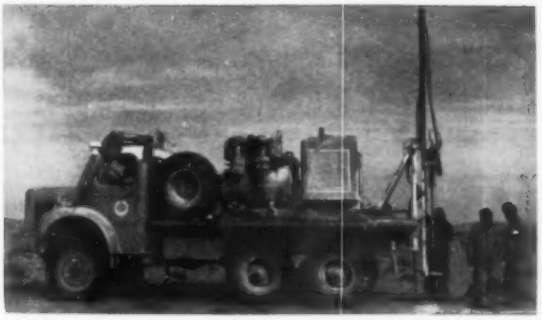
Concessions are defined by 40 x 20 minute cuadriculas. In the case of gravity work these have been broken into 4 x 4 kilometer loops, or in areas where fast reconnaissance is required, 8 x 8 loops.

Surveying production, and to a lesser extent precision, has been affected by the strong northerly winds which prevail for most of the year. At times two surveyor assistants have been required to steady the twelve foot stadia rods in use. Instrument vibration together with effects of heat-haze have been the major bugbear to engineers.

During November and December, the weather was cold and sometimes wet. Rain rendered impassible the major wadis, and fôg or mist precluded early morning surveying. Siroccos, strong winds from the east, while bringing rising temperatures, cut visibility at times almost to nil. However, elevation ties have been held below 25 centimeters per 4x4 kilometer loop.

Aerial photography carried out in April 1960 provided photos to the first crews to start work. These have proved a boon to navigation enabling engineers to pick their way through rough terrain. Oil companies in Las Palmas are also using them in con-

Above: Spanish Legion fort at Haguna protects water wells and neighboring exploration crews



Jack-hammer rig for laying up to 70 shot points per pattern

junction with photogeology. Most of the country was covered by aerial magnetometer in April 1959, and the results have been made available to interested oil companies.

Gravity surveys for six clients have been carried out by six crews of four contracting companies over a vast area. As usual, the results are being used to indicate the location of areas of interest to be worked later, by more definitive geophysical methods. With station production high because of the generally flat terrain, many blocks have already been finished. At this stage statistics are not available on the work completed. Several gravity crews, after having completed contracts for their original clients, have since been engaged by oil companies with a lesser number of concessions.

Close integration between the gravity results, Geograph, and seismic profiles, is now being studied by clients planning their future geophysical and drilling programs.

Nine conventional seismic crews are at present working in the Spanish Sahara. Originally oil companies were interested in long profile lines to give an overall picture in conjunction with gravity work that had previously been done in those areas. Most crews are now doing detail work.

Drilling has in places met with hard going in dense limestone. In other areas, stringers of quartzite have slowed production. Some crews are using a variety of rigs on the same profile. Standard Failing and Mayhew rigs are working alongside the shallow depth jack-hammers. These latter have been used to lay patterns of up to 70 holes at one to two meter depth.

Both reflection and refraction techniques have been used but technical information is yet to be fully assessed.

Two weight dropping crews are also at work on concessions. This simplified method of seismic recording, after its success in West Texas and Libya, was introduced into the Spanish Sahara in October 1960.

The Geograph, or "Thumper," is a seismic system involving special techniques in combining the use of FM magnetic tape with shock wave echoes created by a weight-dropping system. With a three-ton weight as source generator, the hydraulic weight-truck eliminates drills, water-trucks, shooting-trucks, rock bits, drilling mud, dynamite, caps and the associated quantity of personnel.

Proposed profiles are first laid out by an engineer, with spread-stations at intervals interspersed with drop-pattern control points. Contrary to usual seismic procedure, patterns of interconnected geophones are then laid out at each spread-station. Geophone and cable crews are included in the all-round radio link, enabling several spreads to be laid out in advance of the weight-truck and recording unit, thus enhancing production.

The field recording unit is then positioned midway between, and connected by single cables to each adjacent pair of geophone patterns. The weight-truck is driven from station to station along the profile, making drops at about twelve second intervals in predetermined relationship to the drop-pattern-control-points. Each weight drop is controlled by a radio signal from the recording truck.

The seismic signal is detected in each geophone patch and simultaneously conducted to the recording truck via cables. This signal is drop-time corrected and stored on a magnetic tape. Six drops are composited into a single channel on the next tape.

The field tapes are then brought to the field office where the next phase begins. These field tapes are played back on a universal analyzer corrector that has facilities for making static and dynamic corrections as well as normal moveout. The analyzer is capable of making wiggle trace seismic records as well as four different methods of record section presentation on film.

The availability of the field-based playback-analyzer unit enables complete and immediate processing and interpretation of each days' work, thus facilitating programming.

It will be noted by consultation with the concession map that less than half the Spanish Sahara has thus far been contracted in the search for oil. Surface geology has proved quite abundant on most of the concessions and, on most quadriculas still outstanding, some have basement outcroppings while in others shallow basement is suspected.

The mountain ranges down the eastern border of the country have proved of great interest geologically as has the Saguia El Hamra. The latter, a large wadi in places hundreds of feet deep and several miles across, passes through some of the concessions.

Spanish Gulf Oil Co. and Union Oil Co. are as yet the only oil companies that have started drilling. Falcon-Seaboard's slim hole rig has to date completed three holes in quadriculas 9 and 10, and is now completing its fourth. Camdrill spudded in for Union Oil Company early in March and is still in its first hole. Valuable stratigraphic information from these wells is now being studied.

Geophysical information is rapidly approaching the point where an extended program of deep-hole drilling can be initiated.

With the completion of separate phases in the search for oil, some oil companies are now exchanging information in order to obtain a better overall evaluation of their concessions and those in the vicinity.

Some of the concessions not already occupied may well prove of value in the future as the different geological and geophysical results are compared and evaluated, and the geophysical picture takes shape. END

Economics of Oil Transportation Middle East to Western Europe

by Preston P. Nibley
and
Alan C. Nelson

Introduction: This paper deals with the economic factors influencing oil transportation from the prolific oil fields of the Middle East to the highly industrialized consuming areas of Western Europe. This is the largest international movement of petroleum in the world today.

The movement of oil from the Middle East to Western Europe involves a complex transportation system comprising hundreds of tankers, the Suez Canal, dozens of terminals for loading or unloading tankers, and large-diameter pipelines in both areas. This system has developed in recent years into one of high efficiency and low unit cost. Even greater efficiency is expected in the future.

Oil Movements Since World War II: Proved reserves of crude oil in countries bordering on the Arabian Gulf, referred to in this paper as the Middle East, have risen spectacularly since World War II. These reserves were estimated at 26 billion barrels[1] or 37% of the world's total in 1946, but had risen to 182 billion barrels[2] or 60% of the world's total at the end of 1960.

During this same period, crude oil production in the Middle East increased from 690,000[1] to 5,240,000 barrels per day.[2] From 9% of the world's total in 1946, it rose to 25% in 1960 (Figure 1).

Soon after World War II, Western Europe became the major market for Middle East oil, and since 1950 it has been the market for well over half the total (Figure 2). Table 1 shows the destination of Middle East oil exports during this period ("oil" as used in this paper means both crude oil and refined products):

Table 1—Destination of Middle East Oil Exports
(Thousands of barrels per day)

	1946[1]	1950[3]	1955[4]	1960[5]
To:				
North America	8	166	299	484
South America	8	39	70	68
Asia and Australasia	311	284	500	1,189
Africa	52	138	175	225
Western Europe	128	895	1,880	2,724
Total	507	1,522	2,924	4,690
Western Europe Percent of Total	25.2	58.8	64.2	58.1

To move an increasingly larger volume of crude oil to local refineries or to deep-water tanker terminals, a network of large-diameter pipelines has been developed in the Middle East (Figure 3). Most of these pipelines terminate at refineries or at tanker loading terminals on the Arabian Gulf coast, from which crude oil and refined products are shipped to major importing areas. The pipelines from oil fields of northern Iraq and the trans-Arabian pipeline system from the producing fields of Saudi Arabia terminate on the Eastern Mediterranean.

The increase in movement of oil by sea from the Middle East to Western Europe has been paralleled by the growth of the world tanker fleet. Since 1946, the transportation capacity of this fleet increased over threefold (Figure 4). During the first ten years after the war the growth was gradual, but there was a significant trend toward larger and faster tankers, often referred to as "supertankers," of approximately 25,000 to 35,000 deadweight tons. A major expansion of the fleet began about 1955, and a changeover to even larger tankers was given impetus by the closure of the Suez Canal in 1956.

The most important oil shipping route from the Middle East to Western Europe is through the Suez Canal. The second in importance is from Eastern Mediterranean pipeline terminals of the Iraq Petroleum Company and the Trans-Arabian Pipe Line Company. A less important route, except for the period of the Suez Canal closure, is around the Cape of Good Hope. The magnitude of the oil movement by the Suez Canal and by the pipelines to the Eastern Mediterranean is shown in Figure 5.

Economics of Transportation: Crude oil can be transported by different routes and means from the Middle East to Western Europe. The basic rule of economics affecting these movements is that, in the

◄ PRESTON P. NIBLEY was formerly manager of operations of the New York office and chief engineer of the Trans-Arabian Pipe Line Company. He received a B.S. degree in petroleum engineering from the University of Oklahoma in 1940 and the degree of engineer in petroleum engineering from Stanford University in 1942 at which time he joined Standard Oil Company of California. He transferred to Tapline in 1950. On October 1, 1961, he joined Socony Mobil Oil Company as an engineering consultant.

ALAN C. NELSON, Superintendent of Operations for the Trans-Arabian Pipe Line Company, received his B.S. in Chemical Engineering at Michigan State University. He entered the oil industry in 1933 with the Pure Oil Company as a chemist and cargo inspector. He held a number of other positions in the oil industry and joined Tapline in 1948. ►

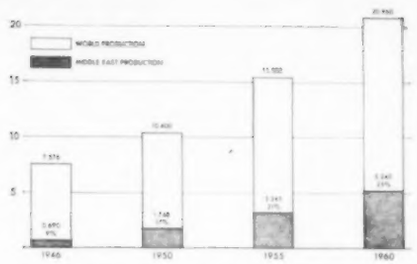


Fig. 1—Middle East and World Crude Production

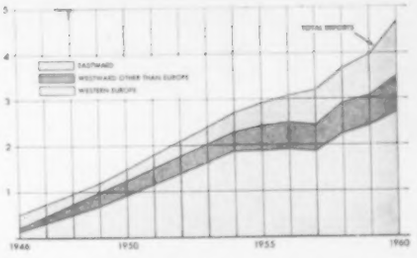


Fig. 2—Destination of Middle East Oil Exports

long term, an increasing proportion of oil will tend to move by that route and means which provide the lowest cost as measured by the investment required and the cost of operation. It is the combination of investment and operating cost which is important, for large-scale investments may sometimes be justified in order to bring about the lowest operating cost.

Each class of facilities involved in these movements will be considered with respect to the economics influencing its development.

Tankers: The most striking development in the tanker industry since World War II has been the spectacular growth in tanker size and speed. In 1946, the average tanker was 12,500 deadweight tons with a speed of 12.85 knots,[1] and the largest afloat was about 24,000 tons. By December 31, 1960, the average tanker had increased to 21,900 tons with a speed of 15.1 knots,[6] and the largest afloat had increased more than fourfold to 107,000 tons.[7] Furthermore, tankers on order for delivery during the period 1961-65 average over 41,000 tons,[8] and recently Japanese interests have announced plans to build two 130,000 ton tankships.

The reason for this trend is that larger tankers can move oil at lower cost than smaller tankers. Larger tankers can be operated by about the same number of men as the smaller ships, reducing the cost of labor per barrel transported. For example, only 50 men are required to operate a 100,000 ton tanker as compared to 41 men for a T-2 tanker.[9] Fuel consumption per barrel moved decreases as the size of the tanker increases, even though the larger and newer tankers generally are faster than the smaller and older types. Also, the investment per deadweight ton for a large tanker is much less than that for a smaller ship, since the shipbuilding costs and the steel requirements are relatively lower. The reduced investment per unit of carrying capacity results in lower depreciation, interest and insurance charges per barrel of oil transported.

The effect of tanker size on unit transportation cost is shown in Figure 6.[10] This graph indicates that a 46,000 deadweight ton tanker can move oil for about 50%, and an 85,000 deadweight ton tanker for about 40%, of the cost per barrel of oil for a T-2 tanker of 16,600 deadweight tons.

Even slight savings per barrel are important when related to large-scale movements of oil. As the volume of the oil movement grows, shipping costs strengthen the trend toward larger tankers. But larger tankers require deepwater terminals with adequate tank farm capacities. Thus, the use of the largest tankers will be restricted to particular sources, routes and destinations where suitable terminal facilities are available or where the volume of oil handled justifies their construction.

Suez Canal: The Suez Canal is of vital importance in the economic movement of large quantities of crude oil from the Middle East to Western Europe. As indicated in Figure 7, the round-trip distance from Mina al Ahmadi, Kuwait, to Rotterdam via the Canal is 9,500 nautical miles less than the round-trip distance around the Cape of Good Hope. Figure 8 shows that the number of tankers passing through the Canal per day increased substantially during the period 1946-1960, as did the number of all classes of ships. The average size of tankers using the Canal also increased. Accordingly, the volume of oil moving through the Canal went up even more sharply, as shown in Figure 9.

The Suez Canal Authority has made a series of improvements to increase the capacity of the Canal. The maximum permissible draft for ships was increased to

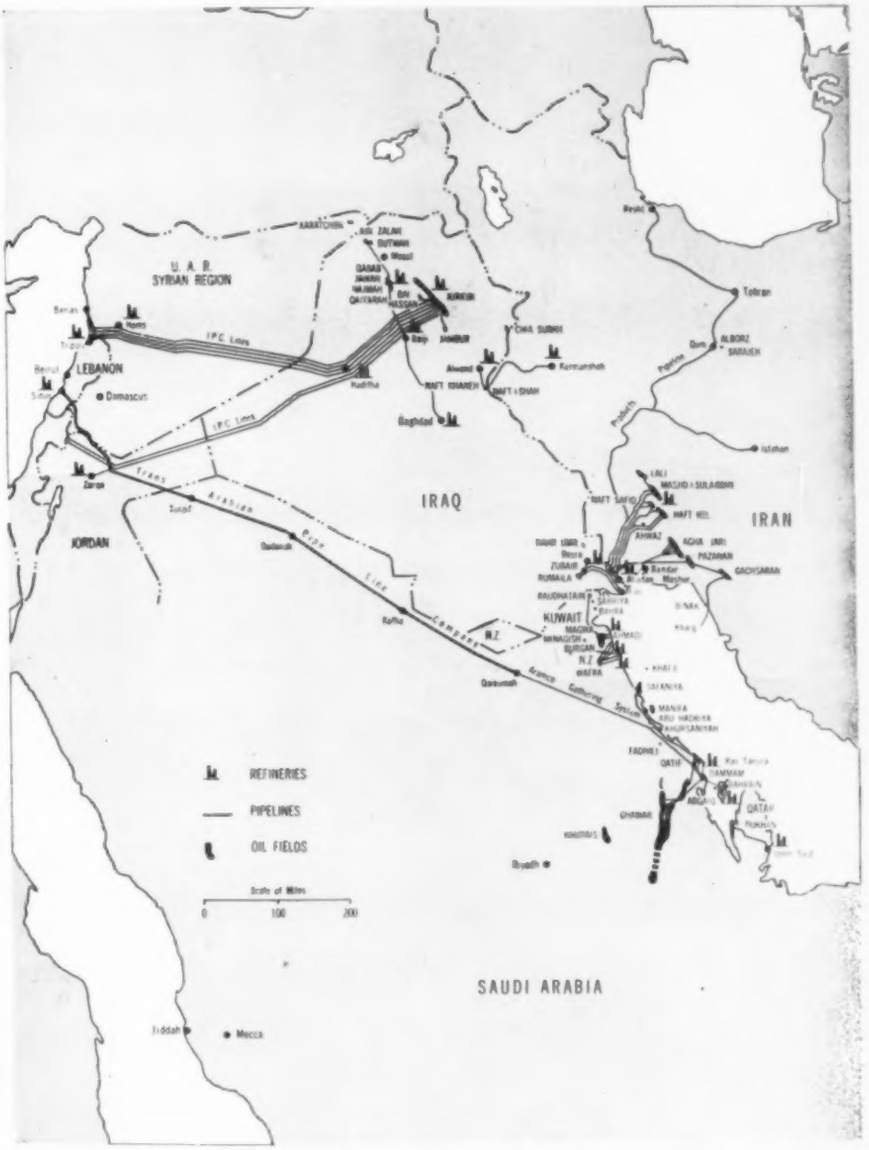


Fig. 3—Middle East Oil Facilities

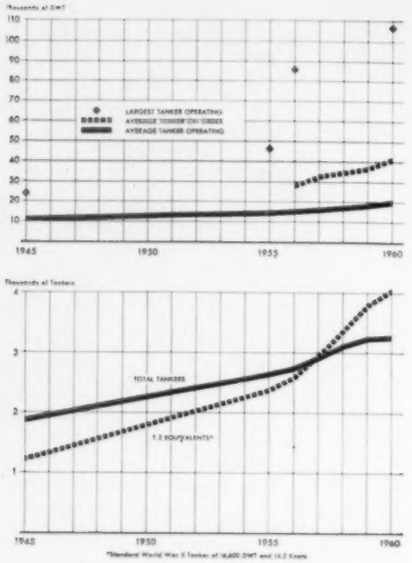


Fig. 4—Trends in World Tanker Fleet

36 feet on February 15, 1961 and to 37 feet on May 1, 1961. Although there is no constant relationship between draft and deadweight, with 37 feet permitted, most tankers up to 46,000 tons can now pass through the Canal fully loaded.

Economic considerations probably will govern the extent to which the Canal is deepened and otherwise improved in the future. If current trends toward larger tankers and greater volume of traffic continue, it seems likely that the Suez Canal Authority will find it financially attractive to proceed with additional improvements.

While the Canal was closed in 1956-57, there was a large-scale movement of oil from the Arabian Gulf around the Cape of Good Hope to Western Europe. After the Canal was reopened, this movement dropped sharply. Recently this route has been used by tankers which either are too large to pass through the Canal fully loaded or because of the tanker surplus are being routed around the Cape to increase operating time and thereby avoid the expenses and disruptions of short-term lay-ups.

Movement by the Cape route probably will continue for tankers larger than 46,000 tons. However, it should be economically attractive for even these tankers to return in ballast through the Canal to the extent that physical limitations allow; the Suez Canal Authority has reported successful transits in ballast of tankers as large as 85,000 deadweight tons. Economic analyses indicate that the cost of moving oil to Western Europe by 85,000 ton tankers around the Cape and returning in ballast through the Canal is about the same as the cost of using 46,000 ton tankers through the Canal both ways.

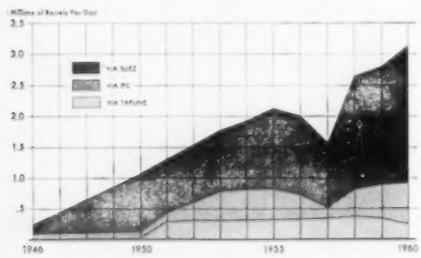


Fig. 5—Westward Movement of Middle East Oil via Suez and Pipelines to the Eastern Mediterranean

Terminals: Deepwater terminals capable of berthing tankers up to 100,000 tons either have been completed or are planned at most of the major crude oil exporting centers in the Arabian Gulf. On many occasions the Kuwait Oil Company's giant terminal at Mina al Ahmadi has loaded tankers of the Universe Apollo (106,000 deadweight tons) and Universe Leader (85,000 deadweight tons) classes. The Arabian American Oil Company's terminal at Ras Tanura has handled tankers of the Universe Leader class regularly and can accommodate tankers of 100,000 tons. The Basrah Petroleum Company is currently building a sea island off southern Iraq, which is designed to berth tankers of up to 100,000 tons. The Iranian Oil Participants commissioned in 1960 a new deepwater terminal at Kharg Island off Iran, which can accommodate 100,000 ton tankers. These terminals are being used by "giant" tankers carrying crude oil to deepwater terminals in consuming areas to the eastward as well as around the Cape to Europe and North and South America.

Similarly, the pipeline terminals along the Eastern Mediterranean coast are capable of berthing tankers up to 85,000 deadweight tons. The Universe Leader has been loaded at Sidon, Lebanon, the terminus of the Trans-Arabian Pipe Line Company (Tapline), and improvement of the berth facilities has been planned to allow mooring tankers up to 100,000 tons on a regular basis. The Iraq Petroleum Company's terminal at Banias, Syria, presently can accommodate tankers up to 85,000 tons, and its terminal at Tripoli, Lebanon, is being improved to handle tankers of that size. In addition, Esso Standard (Libya), Inc. is installing a terminal at Marsa El Brega, Libya, which will be able to moor 100,000 ton tankers.

Development of deepwater tanker-unloading terminals at key locations in Western Europe (see Figure 10) is also progressing. Esso Petroleum and British Petroleum recently commissioned terminals at Milford Haven in the United Kingdom, which are capable of berthing tankers up to 100,000 tons. Shell Petroleum has completed a terminal for handling 65,000 ton tankers at Tranmere, United Kingdom. The new Esso refinery at Slagen, Norway, has a pier capable of berthing 100,000 ton tankers. Rotterdam and Wilhelmshaven, the terminals for the recently built crude oil pipelines into Western Germany, are being expanded and improved to handle 100,000 and 85,000 ton tankers, respectively, by 1965. The crude oil unloading terminal to be built at Lavera, France, for the South European Pipe Line will have

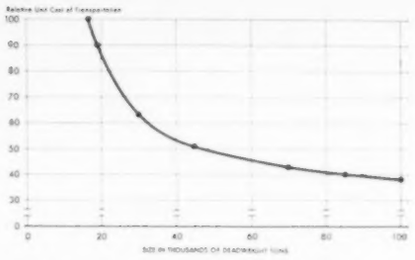


Fig. 6—Unit Cost of Transportation Related to Tanker Size

a submarine berth capable of mooring 85,000 ton tankers.

The widespread development in the Middle East and Western Europe of oil terminals for accommodating tankers in the 65,000-100,000 ton range provides physical evidence of the economic attractiveness of these larger vessels.

Pipelines: Except for tankers, pipelines usually provide the lowest cost means of moving crude oil. On a parallel long-distance movement, a crude oil pipeline cannot compete in operating cost with a modern tanker. Most crude oil pipelines are built, not to compete with tankers, but to provide a means for moving oil from producing fields to tanker ports or to refineries. Also, another type of crude oil pipeline system is being increasingly provided in Western Europe—one in which the pipeline moves oil from a tanker unloading terminal to an inland refining center. For inland movement of crude oil at rates of 50-100,000 barrels per day or more, large-diameter pipelines usually have a competitive advantage over railroad tank cars, tank trucks, and barges. However, each transportation problem of this type must be analyzed separately.[9, 11]

In the Middle East, all major crude oil pipeline systems, with one exception, provide the sole outlets from producing fields to refineries or to tanker loading terminals.

Fig. 7—Tanker Routes—Middle East to Western Europe

The most extensive such system is operated by the Iraq Petroleum Company between the producing fields of the Kirkuk area and the Eastern Mediterranean. IPC's deliveries to tankers at the terminal ports of Banias and Tripoli rose to a new high of 679,000 barrels per day in 1960. This company is installing additional facilities to raise the capacity of this system to about 1,000,000 barrels per day by 1962.

The only major pipeline in the Middle East which does not fall into this exclusive outlet category is the Trans-Arabian Pipe Line. This is because oil from Saudi Arabian producing fields can move westward by either of two routes. Unlike IPC, Tapline competes with tankers in the movement of crude oil from the Arabian Gulf to the Eastern Mediterranean. It is capable of competing only because its route is an almost straight line from the producing areas of Saudi Arabia to the Mediterranean terminal at Sidon, whereas tankers must take the longer route around the Arabian peninsula and then pass through the Suez Canal.

The economic attractiveness of large-diameter crude oil pipelines for inland movement is indicated by the growing trend toward this method of transportation in Western Europe. In late 1958, the first major line of this type was completed between Wilhelmshaven and the refining center in the Cologne area of West Germany. In 1960, a similar system was placed in operation between Rotterdam and refineries in the Ruhr. Construction has started on another major line between the Mediterranean port of Lavera and refineries in the Strasbourg and Karlsruhe area. This line will be 34 inches in diameter and will have an ultimate capacity of about 600,000 barrels per day. Its planned extension to Bavaria has been announced. Another line is under construction from Genoa through Switzerland to West Germany. Other similar systems are under discussion or planned.

Developing Pattern of Crude Oil Transportation: A new transportation system is evolving which will reduce transportation costs considerably. From the Arabian Gulf to Western Europe, the lowest cost tanker transportation will be provided by the largest tanker that can pass through the Canal fully loaded. As of May, 1961 this is a tanker of the 46,000 ton class. For movement from the Eastern Mediterranean to Western Europe, terminal facilities will soon be available to permit tankers up to 100,000 tons in size to operate in this trade. Possibly the lowest cost transportation from the Arabian Gulf will then be provided by a combination of crude oil movement through the trans-Arabian pipeline system and "giant" tankers carrying the oil between Tapline's Sidon terminal and Western Europe. However, in spite of Tapline's exceptionally low unit operating cost, the over-all cost of moving oil through Tapline is largely dependent upon the level of payments to be made to the governments of the countries through which it passes. The governments are requesting higher payments, but the amount of these payments has yet to be determined. Furthermore, Tapline's competition will become increasingly severe as the Suez Canal is improved to handle larger and larger tankers.

In addition to the use of "giant" tankers for the largest oil movements, smaller tankers in the 16,000-30,000 ton range, will be used for many years for those Western European destinations where port and terminal facilities are limited and market demand is insufficient to justify the necessary investments for handling the larger tankers.

Forecast Through 1965: *Net Oil Imports Into Western Europe:* A detailed report on Western Europe's future energy requirements was released in January, 1960, by the Energy Advisory Commission for the O.E.E.C.[12] This report was reviewed by M. E. Hubbard[13] with particular reference to the forecast demand for oil. Mr. Hubbard brought out the following highlights:

1. For the period 1955-75, well over one-half of the growth of Europe's energy requirements will be met by increased imports of oil.
2. The average annual increase in oil imports for the period 1960-75 will be about 200,000 to 220,000 barrels per day.
3. The annual rate of growth will fall well below the 11 to 15% of the immediate postwar period, to possibly 4 to 5% by 1970.

A more recent published report by P. H. Frankel and W. L. Newton[14] includes data from which net oil imports to Western Europe can be calculated. These show a higher level than even the "maximum" forecast of the O.E.E.C. Energy Advisory Commission (Figure 11). Actual net imports through 1960 indicate that the Frankel and Newton forecast may be more realistic than the O.E.E.C. Commission forecast, and that both may be too conservative. The annual growth rate of net imports as predicted by Messrs. Frankel and Newton averages about 7% for the period 1960-65 and 5 to 6% for the period 1965-70. Actual growth of net imports for the period 1955-60 was about 11% per year.

Following is a comparison of the O.E.E.C. Commission and Frankel and Newton forecasts through 1970:

Table 2—Net Oil Imports to Western Europe

	1960	1965	1970
	(Thousands of barrels per day)		
O.E.E.C. Commission (maximum forecast)	3,200	4,340	5,600
Frankel and Newton	3,400	4,740	6,320
Actual reported	3,700	—	—

Sources of Imported Oil: At present, Western Europe imports oil mainly from the Middle East, South America (including the Caribbean), the U.S.S.R., and North Africa. Statistics available from the Suez Canal Authority and other sources provide a reliable estimate of the magnitude of oil movement from the Middle East to Western Europe. These figures indicate that about three-fourths of Western Europe's net imports came from the Middle East in 1959 and 1960, as shown below:

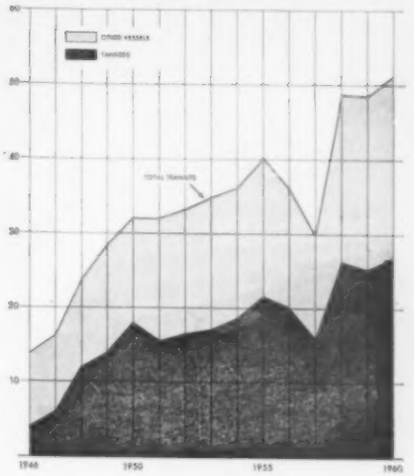


Fig. 8—Suez Canal Average Daily Transits (North & South)

Table 3

	1959		1960	
	(Thousands of barrels per day)			
Net Oil Imports	3,100	(100%)	3,700	(100%)
Movements to Western Europe from the Middle East	2,400	(78%)	2,700	(73%)
Balance from Other Sources	700	(22%)	1,000	(27%)

South America ranks second to the Middle East as a supplier of oil to Western Europe. In 1959, this area furnished about 500,000 barrels per day. Most of the balance of 200,000 barrels per day was supplied by the Soviet bloc and North Africa. In 1960, Western Europe's imports from South America remained at about 500,000

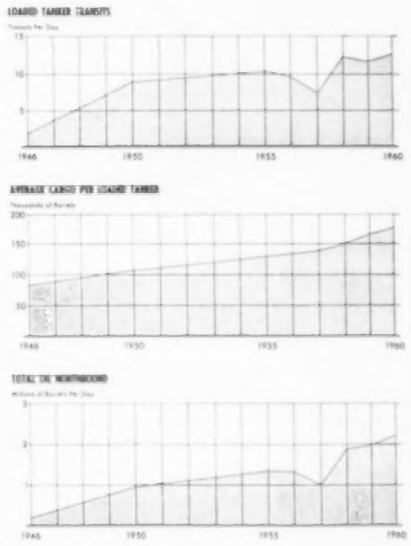


Fig. 9—Suez Canal Northbound Oil Movement

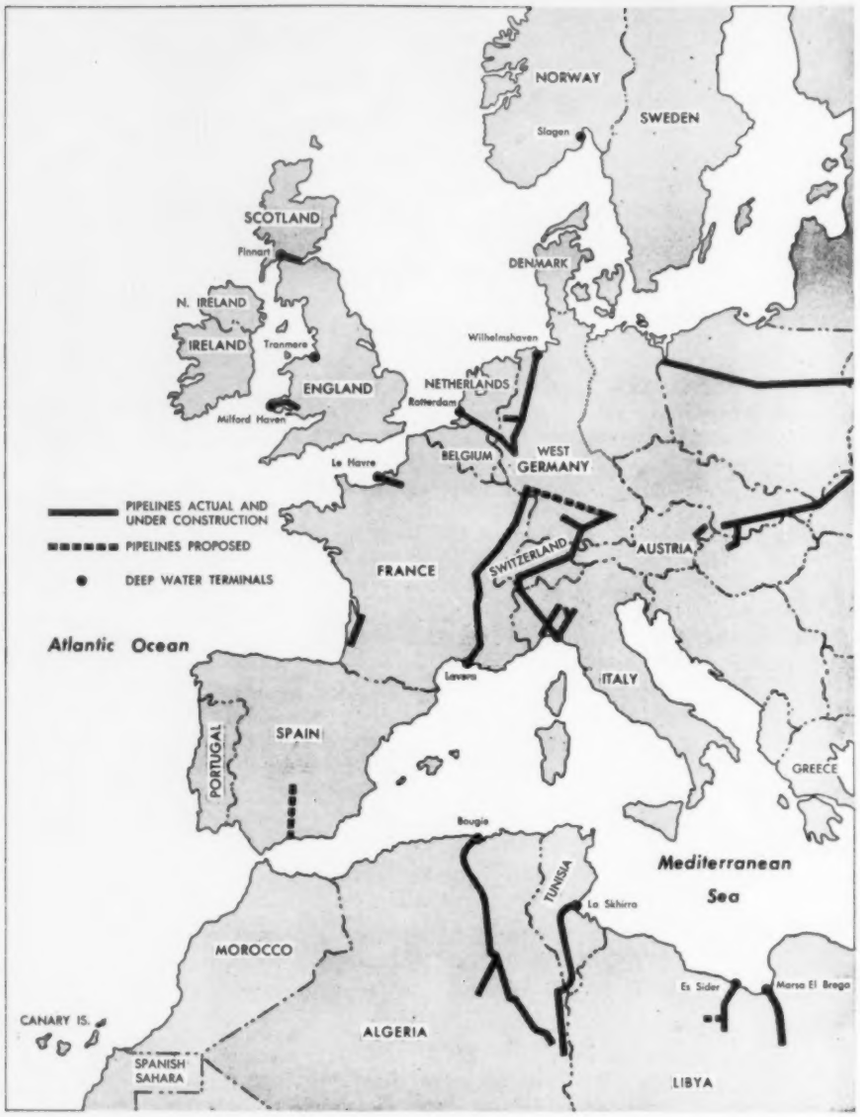


Fig. 10—Major Oil Terminals and Pipelines

barrels per day but imports from the Soviet bloc increased to approximately 300,000 barrels per day. The balance of 200,000 barrels per day was imported mainly from North Africa (Algeria).

In looking ahead through 1965, it would appear that the Middle East, because of its immense reserves and low unit production costs, will continue to be the main source of oil for Western Europe. But developments in the last few years indicate that the U.S.S.R. and North Africa will supply increasingly larger percentages.

E. P. Gurov, Chairman of the Soviet Foreign Trade Organization, "Sojuznefteexport," announced at the Second Arab Petroleum Congress in Beirut October 1960 that the U.S.S.R. intends to regain its pre-World War II percentage of markets for oil. He stated that in the "prewar decade, 1925-35, western countries' imports totalled about 210 million tons of crude oil and petroleum products, including 30 million tons (14.3%) from theU.S.S.R."[15] Furthermore, for political and economic reasons, the U.S.S.R. appears willing to barter and to price its oil low enough to force its way into the highly competitive markets of Western Europe. On the other hand, Robert Marjolin, Vice President of the European Common Market Commission, advises that Western European countries should not become too heavily dependent on the U.S.S.R. for oil supplies and should limit their imports from that source to about 10%.[16] Thus the Soviet bloc exports to Western Europe through 1965 might be considered to be in the range of 10 to 14% of net imports.

Within the last few years, North Africa has emerged as a major source of oil. Algerian production passed a rate of 300,000 barrels per day at the end of 1960, and facilities are planned for more than doubling this rate by 1964.[17] A number of sizable oil fields have been found in Libya. One large-diameter pipeline to the Libyan coast for the export of oil from the Zelten field is scheduled for completion in late 1961. A second line is planned for completion in 1962. It is possible that Libyan production will reach a level of about 400,000 barrels per day by 1964.[17] Because of its proximity, oil from North Africa has a competitive advantage over Middle Eastern oil in Western Europe.

Sufficient information is available to assemble a forecast range of net imports and sources of oil for Western Europe in 1965, as compared with the estimated figures for 1960. Although forecasting is a hazardous undertaking, the following assumptions will be made on the basis that they represent reasonable *probabilities:*

1. Imports from North Africa will rise substantially as export capacity increases, especially in the preferential market already being given by France.
2. Imports from the U.S.S.R. will increase as the Soviets develop a greater export capacity.
3. Imports from South America will not show any appreciable increase above the 1960 level.
4. Imports from the Middle East will fill the balance of the increase in Western Europe's net imports:

Table 4—Net Imports and Sources of Oil for Western Europe

(Thousands of Barrels Per Day)

	1960*	1965	
Western Europe Net Oil Imports	3,700	4,700†	5,400‡
Source of Oil:			
North Africa	200	800	800
USSR (Assume roughly 10 to 14% of Western Europe's net imports for 1965)	300	500	700
Other	500	500	500
Sub-Total	1,000	1,800	2,000
Balance From Middle East	2,700	2,900	3,400
Increase From Middle East Over 1960		200	700

* Latest estimates.
† Forecast by Frankel and Newton.[14]
‡ Forecast representing an 8% per year increase over 1960 based largely on 13.7% per year increase for period 1950-55 and 10.6% per year for period 1955-60.

Although such a forecast is based upon many uncertainties, the important conclusion is that the potential availability from North Africa and the USSR appears to be of sufficient magnitude to supply *most of the increase* in Western Europe's needs through 1965. A corollary is that there will be a reduction in the rate of increase of movement of oil from the Middle East to Western Europe.

Transportation Facilities Required: Tankers: There has been an oversupply of tankers since the Suez Canal was reopened in 1957. The surplus was especially severe during the summers of 1959 and 1960. It was relieved by increased demand for oil and scrapping of older, obsolete tankers in the winter of 1960-61. However, forecasts indicate there will be a surplus of tankers for several years.

Tanker supply lines to Western Europe

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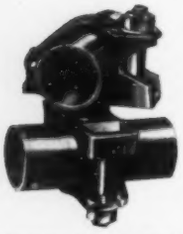

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will be shortened considerably by availability of oil at North African ports, as compared to ports in the Arabian Gulf, thus aggravating the tanker surplus. These comparisons indicate the magnitude of the reduction in mileage:

Table 5—Round-Trip Distance in Nautical Miles

Mina al Ahmadi, Kuwait-Milford Haven, U.K.	12,580
Marsa El Brega, Libya-Milford Haven, U.K.	4,980
Reduction	7,600
Bandar Mashur, Iran-Lavera, France	9,700
Bougie, Algeria-Lavera, France	800
Reduction	8,900

For every 100,000 barrels per day supplied from Bougie to Lavera, to cite only one example, there will be a decrease in tanker requirements of 28 T-2 equivalents as compared to moving this same amount of oil from Bandar Mashur to Lavera.

Suez Canal: One aspect of vital concern in the movement of oil from the Arabian Gulf by tanker to Western Europe is the ability of the Suez Canal to handle the increasing traffic. So far, the Suez Canal Authority has been able to accommodate the increasing number of ships desiring transit, and it appears that the Authority intends to continue an improvement program as it deems necessary to meet increased traffic.

Even though there will probably be continued growth in oil movement through the Canal, two factors will tend to reduce the rate of increase of tanker traffic. One is that the rate of increase of oil movement from the Middle East to Western Europe will diminish as North Africa and the U.S.S.R. supply increasing quantities. The second is that the average size of tankers using the Canal will continue to increase, and therefore the rate of increase of tanker transits will tend to level off. In 1960 northbound oil movement through the Canal averaged 2,289,000 barrels per day and the average cargo per northbound loaded tanker was 24,600 tons. If the average cargo increases 50% to 36,900 tons in the mid-1960's, the northbound oil movement could rise to 3,400,000 barrels per day without any increase in the number of tanker transits.

The Canal's total traffic is influenced by so many factors that it is difficult to predict its capacity and volume of traffic far into the future. However, it appears that the Canal Authority is willing to assume the responsibility for meeting the demands upon the Canal and that there will be no "saturation" of its capacity through 1965 and possibly through 1970.

Pipelines: Capacities of major crude oil pipelines in the Middle East providing sole production outlets will increase as necessary. Tapline, however, is in direct competition with tankers, and expansion of its capacity will depend upon the relative economic attractiveness of moving oil from Saudi Arabia by tanker or by Tapline. At present, the most efficient tanker movement from the Arabian Gulf to Western Europe is a 46,000 ton tanker passing through the Suez Canal fully loaded. Because of the low unit cost of moving oil by a fully loaded 46,000 ton tanker, it is doubtful that it will be economically attractive to undertake a major expansion of Tapline—especially if Tapline is required to pay the high level of payments being demanded by Middle East governments. It is even more doubtful that a new pipeline system, in direct competition with tankers, would be economically attractive in the near future.

Furthermore, there is already some spare pipeline capacity to the Eastern Mediterranean. Tapline has not operated at capacity for any extended period since late 1957. With the expansion planned by IPC to Banias and Tripoli, the combined capacity of its system and Tapline will be about 1,500,000 barrels per day by 1963. These systems delivered a total of about 920,000 barrels per day in 1960. Thus, by 1963 the capacity will exist for moving an additional 580,000 barrels per day by pipeline from the Middle East to the Eastern Mediterranean.

Conclusion: Middle East production and export of oil to Western Europe have risen spectacularly in the period 1946-60. Efforts to move oil at the lowest cost have caused the evolution of an increasingly efficient transportation system. The magnitude of movement has reached such large proportions that it has been economically attractive to use increasingly larger tankers and to provide terminals for them in both the Middle East and Western Europe. Also, large-diameter pipelines are being built in Western Europe to allow movement of the oil from deepwater terminals to inland refineries at low unit costs. The resulting combination of "giant" tankers and large-diameter pipelines will provide a transportation system of high efficiency.

The emergence of North Africa and the U.S.S.R. as potentially large-scale suppliers of oil to Western Europe will probably retard the increase of Middle East oil movement to Western Europe. This trend, together with the use of increasingly larger tankers, will tend to cause the number of tankers transiting the Suez Canal to level off in the near future.

For the next few years, there appear to be adequate transportation facilities for supplying Western Europe with its predictable requirements of Middle Eastern crude oil. The most efficient of these transportation systems involve the use of 46,000 deadweight ton tankers moving fully loaded through the Suez Canal from the Arabian Gulf, and the use of even larger tankers loading at the pipeline terminals on the Eastern Mediterranean. Perhaps at some future date, after the current tanker surplus has abated, additional pipeline capacity from the Arabian Gulf to the Eastern Mediterranean will be economically attractive. Such a possibility will depend to some degree on the level of payments made to the Middle East governments. But any proposals for enlarging the existing pipeline facilities or for creating new ones will have to be carefully examined in the light of the availability of alternate means of transportation.

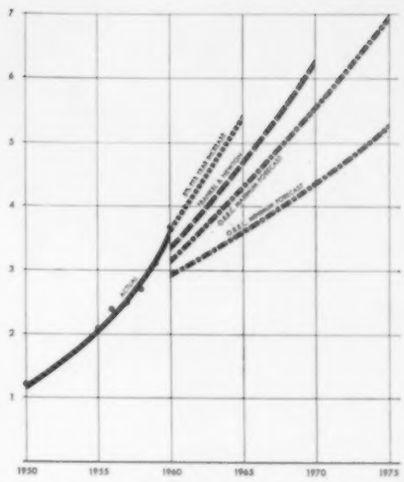

Fig. 11—Net Oil Imports of Western Europe

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Note: Some of the statistics in these and other references were originally expressed in terms of tons per year. These figures have been converted here into barrels per day, in accordance with normal American practice, on the basis of the approximate conversion factor that "tons per year," divided by 50, equals "barrels per day."

A timely new development in new uses for fuel oil—Esso Research's mobile snow-melting machine in a test demonstration

New uses, wider markets open for old, established products

by Virgil B. Guthrie*

THE FUELLING of commercial jet airliners with kerosine is only one phase—though a significant one perhaps—of a continuing trend towards new fields of utilization for long established petroleum products. Other new applications on the horizon include such possibilities as the use of heavy fuel oil to replace coke in blast furnaces, expanding possible uses for middle distillates in agriculture, and the conversion of distillates into energy in hydrocarbon fuel cells.

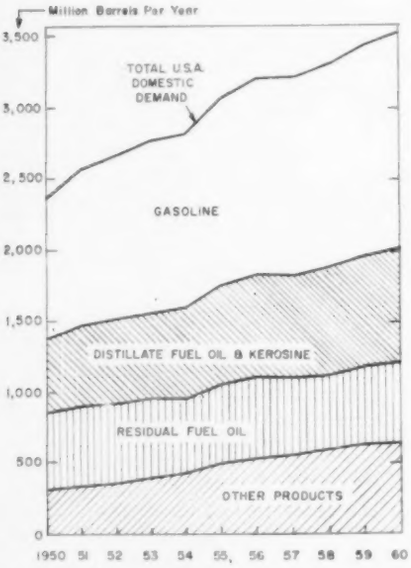


Fig. 1—USA domestic demand for four volume products. Bureau of Mines Data. Note: "Other products" include LPGas, jet fuels (starting in 1952), lubes, wax, coke, asphalt, road oil, specialty products, and still gas

These are noteworthy developments in the continuing search for wider fields of usefulness for petroleum which is being carried on by the larger oil companies and by agencies of some of the larger petroleum-consuming industries. Over the years, these efforts have resulted in the introduction of hundreds of new commercial products and have expanded the fields of usefulness of others.

Two basic factors have impelled this activity. First, fundamental research into the composition and molecular structure of the hydrocarbons in petroleum has established that they are in effect storehouses of raw materials capable of conversion into many valuable products. Second, the low per pound value of the original materials—one or two cents for crude oil and some intermediates—is a strong incentive to transform them by further processing into products, some of which—petrochemicals for example—have market values of 10 or 12 cents a pound or even higher.

Today, one more economic incentive exists. The slowdown in the rate of gain in consumption of gasoline and heating oils—the industry's largest volume markets—emphasizes the need to find new uses for those products whose principal markets now are as low-value fuels.

The annual rate of gain in gasoline consumption over the next few years is expected to be 2 to 3% in the USA and that for heating oils on the same order. This is bringing in a degree of competition which did not exist in these markets when the industry could look forward to annual gain rates of 5 to 6% in sales of these products.

For more than one reason, in studies of wider product utilization, interest is centering on the middle distillates. These include kerosine and distillate fuel oil, both of which now have diverse domestic and industrial uses. Growth in demand for the middle distillates, as well as other major product groups, is shown in Fig. 1. Middle distillates now supply 23% of all USA petroleum requirements. Their demand has increased 60% in the past decade, while that for gasoline has gained 53%.

Total USA demand for the middle distillates in 1960 was 818 million bbl, of which 132 million bbl was kerosine and 686 million bbl distillate fuel oil. The largest current market for the distillate fuel oils is as heating oils. Consumption of the four grades of the distillate heating oils in 1960 was about 423 million bbl, some 62% of total sales. Competition in the space heating field with natural gas and other fuels determines the relatively low realization value the refiner receives for his output of distillate fuel oils.

The second largest use of distillate fuels is as diesel fuel. Sales of railroad, automotive and marine diesel fuel in the USA in 1960 came to some 161 million bbl. Consumption of automotive diesel fuel is growing; sales in 1960 were 60% greater than in 1956. Some No. 2 grade distillate heating oil is sold as diesel fuel.

The slowing down in the rate of gain in consumption of heating oils is spurring oil companies in research to find means to increase the efficiency of these oils, to improve

*Mr. Guthrie, a previous contributor to this magazine, is the editor of the "Petroleum Products Handbook," and formerly editor of *Petroleum Processing*.

TABLE 1—Physical and Chemical Requirements for Kerosine for Principal Uses

Property	Illuminant in a Wick Lamp[1]	No. 1 Fuel Oil[2]	Comm. aircraft Jet fuel[3]
Gravity, °API, min	—	35	39
Flash pt, °F, min	115	110 or legal	100 or legal
Pour pt, °F,	—	0	—40
Freeing pt, °F, max	—	—	—40
Cloud pt, °F,	5	—	—
Distillation, °F.			
10% evap, max.	—	420	400
Final boiling pt	—	625	550
Sulfur, % max	0.13	—	0.3
Burning test, hrs, min.	16	—	—

[1] Federal specification, kerosine, VV-K-211c, 1952.
[2] Federal specification, fuel oil, burner, VV-F-815, 1951.
[3] ASTM Designation Type A, D 1655, 1959 Tentative.

TABLE 2—U.S. Refiners' Average Return on the Four Volume Products, per barrel of Crude Oil Processed

Year	Motor Gasoline	Kerosine	Distillate Fuel Oil	Residual Fuel Oil	Total	Price of Crude
1960	$2.204	$0.216	$0.827	$0.229	$3.476	$3.00
1959	2.194	0.179	0.903	0.237	3.513	3.03
1958	2.218	0.175	0.882	0.260	3.535	3.12
1957	2.270	0.185	0.975	0.369	3.799	3.16
1956	2.138	0.198	0.907	0.328	3.571	2.84
1955	2.149	0.189	0.844	0.290	3.472	2.82
1954	2.145	0.208	0.795	0.274	3.422	2.82
1953	2.209	0.204	0.768	0.276	3.457	2.73
1952	2.059	0.227	0.758	0.299	3.343	2.56
1951	2.029	0.236	0.714	0.367	3.346	2.56
1950	1.965	0.216	0.638	0.338	3.157	2.54

NOTE: Realization for products shown is based on average wholesale prices weighted for nine USA refinery markets, as compiled by the Independent Petroleum Association of America. Crude oil prices are average for eight producing areas, also compiled by the IPAA. Product yields on which product output is based are average for all USA refining districts, as reported by the U.S. Bureau of Mines. Data shown are not actual sales realiztions to refiners.

the burners for space heating, and to develop new uses to take up the slack in this market.

The first commercial use of kerosine, as lamp oil, brought a limitation on the flash point of the material that could be sold for this purpose. This was necessary because there was then no market for the lighter naphthas the refiners produced. The practice of some refiners was to include in their kerosine a proportion of the more volatile fractions that now go into gasoline. State laws, in the 1880's, set minimum flash points for kerosine at from 100 to 115 F. Minimum flash points in this range are in effect today for all uses of this material.

Later, requirements for kerosine intended for use as an illuminating oil in wick-fed lamps included distillation points, burning tests, and tests for color and sulfur content. The present federal specifications for kerosine for this use include the requirements shown in Table 1.

Sales of kerosine as an illuminant are a small proportion of total sales in the USA, which were 99.15 million bbl in 1960, excluding jet fuel. The current use of kerosine for space heating came to 79 million bbl in 1960. Here it is known as range oil, or No. 1 grade distillate fuel oil, and is used in vaporizing pot-type burners. Principal requirements for this use as given in the federal and ASTM specifications are shown in Table 1.

The kerosine-type jet fuels for commercial aircraft coming into large use today, 33.16 million bbl in 1960, come from the middle-of-the-barrel distillates and represent the better quality kerosine fractions. Their requirements, as given in the ASTM specifications for Type A fuel, "a relatively high flash point distillate of the kerosine type," include many other characteristics than those common to all kerosines as given in Table 1. These other properties include low pour points and freezing points, Btu heat of combustion in both weight and volume; gum and residue tests; aromatic and olefin content, and smoke point among others.

Some kerosine is used in military jet fuels, where it is blended with gasoline and distillate fuels. The volume so used in 1960 in the USA was 14 million bbl, 16% of the total volume of military jet fuels of 88.25 million bbl. Kerosine blended into military jet fuels is not reported as kerosine by the refiners.

Table 2 shows the average return to USA refiners on the four volume products they manufacture, as related to the price of the crude oil from which they are processed, and over the past ten years. The data bring out the incentive refiners have in finding new and higher value uses for their distillate oils.

In 1960, the return to refiners of $2.204 on gasoline per barrel of crude oil processed represents 19.98 gals (45.2% yield) at 11.61¢ per gal wholesale price. Deducting the cost of crude, 7.14¢ per gal, the margin for the refiner between the cost of his material and his realization was 4.47¢ per gal.

The refiner's return on kerosine in 1960, $0.216, represents 1.932 gal (4.6% yield) at 11.17¢ per gal. The differential between the cost of crude and the wholesale price was 4.03¢ per gal. The refiner's return on 9.41 gal of distillate fuel oil (22.4% yield) at 8.79¢ per gal was $0.827, a differential of 1.65¢ per gal above the cost of crude oil. The realization of $0.229 on residual fuel oil sales in 1960, 4.83 gal (11.2% yield), at 4.88¢ per gal, represented a loss of 2.26¢ between the cost of crude oil and the wholesale price of residual fuel oil.

The spread of $0.476 per bbl between the cost of crude and the refiners' return from the four volume products in 1960 reflects the continuing decline in wholesale prices for distillate fuel oil and residual fuel oils.

The realization figures in Table 2 are based on average wholesale product prices for that year, weighted for nine refinery markets, as compiled by the Independent Petroleum Association of America. The crude oil prices shown are the average for eight producing areas in the USA, also compiled by the IPAA. The product yields on which the refiners' output of the four main products are based are the average for the year for all USA refining districts, as reported by the US Bureau of Mines. The product returns shown in the table are not the refiners' actual sales realization and are not inclusive of all refiners' costs. They reflect product price trends and the differentials between product prices and the cost of crude oil.

New lift for kerosine. New applications, over many decades, have steadily built up the demand for kerosine, the heart cut of the refiner's middle distillate fractions. See Fig. 2. Its current acceptance as fuel for gas turbine powered aircraft is helping build up demand. Total requirements for kerosine in 1960 in the USA were 147.21 million bbl, the highest on record.

Of this volume, fuel needs for the commercial jet airliners by 1960 had reached 36 million bbl, this new use more than taking up the slack resulting from the drop in demand for some other uses. By 1965, the market for this application is expected to reach 75 million bbl. A survey of the turbine-engined fleets of the world's airlines recently made by Esso Air World showed that, as of May 1, 1961, 27 USA companies were operating 420 turbine jet or turbo-prop aircraft, with 265 more on order for delivery by 1964.

Kerosine is also a component of the wide-cut jet fuels used principally by US military planes. Other components are low octane gasoline and distillates. Of the 103.2 mil-

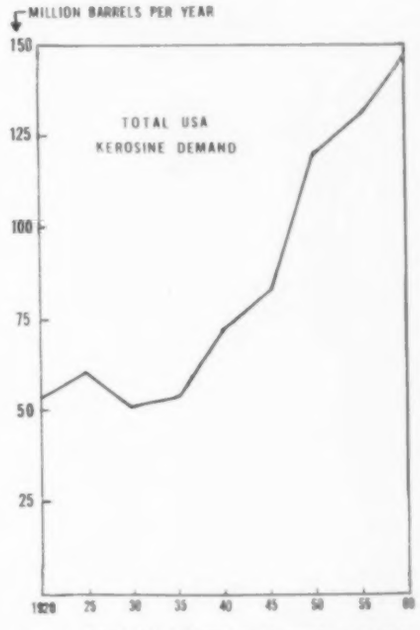


Fig. 2—Total USA kerosine demand, 1920-1960 (includes jet fuel components since 1952). Bureau of Mines data.

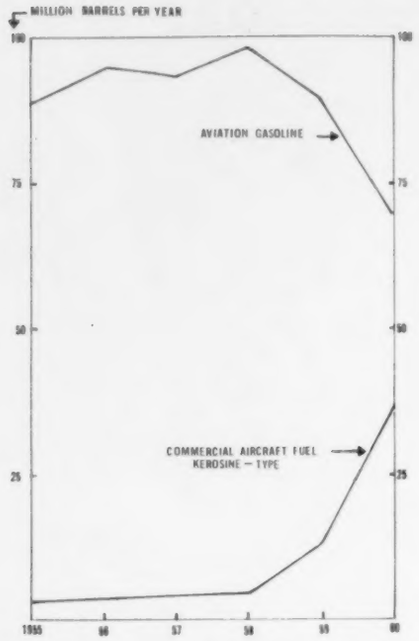


Fig. 3—Trend in demand USA for aviation gasoline and commercial jet fuel (kerosine-type), 1955-1960.

lion bbl of jet fuel demand in 1960 reported by the Bureau of Mines, 14 million bbl (13%) was kerosine.

Technically, the requirements of gas turbine powered aircraft can be met by various petroleum fuels. The selection of kerosine by the commercial airlines was based on other factors as well as suitable properties of the fuel. Supplies of kerosine are available widely, already in the hands of the oil companies, and convenient for delivery to airports, direct from refineries in some instances. For long flights, involving fueling in other countries, more uniformity is to be found in kerosine's properties than in other products. Safety in handling and use was also a factor.

Current refinery production of kerosine is small, in relation to that of other volume products. In 1960, the refinery yield of kerosine in the USA was 4.6% of crude processed. This yield can be increased as required, even at the expense of other distillate products. Within the past decade, refiners have converted as much as 6% of crude to kerosine, and, in the early years when gasoline demand was lower, the kerosine yield was 12 to 15%.

There is no single kerosine type jet fuel. The airlines call for fuels within the kerosine range meeting their own requirements. Most of these fall within the framework of the tentative specifications for two of the three types of aviation turbine fuels issued by the American Society for Testing Materials for commercial use. Type A is a relatively high flash point distillate of the kerosine type. Type A-1 is similar to Type A but incorporates special low temperature characteristics for certain operations. Type B is a relatively wide boiling range volatile distillate. Work is being continued by oil companies and airlines to improve the specification standards for the fuels and widen their availability. The principal differences in properties of commercial kerosine type jet fuels and kerosine for ground use are a lower boiling range, lower freezing point, and higher volume of aromatic content.

The creation of the new market for kerosine as jet fuel has cut into aviation gasoline demand at USA refineries. Total demand for all grades of aviation gasoline reached a post-war peak of 98.342 million bbl in 1958. In 1960, it was 69.82 million bbl, and by 1965 it may be down to 50 million bbl. The changing pattern in demand for aviation gasoline and jet fuel is shown in Fig. 3.

New uses for distillate fuel oil. The large refinery output of distillate fuel oil, its present diverse uses, and the average low realization value for refiners for this product have combined to center interest in developing new, higher value uses for it.

Wide agricultural markets are under study by various agencies, including three midwestern agricultural colleges, G. W. Flint, American Oil Co., told an API meeting on the subject earlier this year. In coming years much more energy and combustion equipment will be required on farms, and it might be well to steer this demand toward the use of distillates, he stated, "because in the long run they would be cheaper and safer to use."

Two potentially large new agricultural uses for distillate fuels, he said, are in crop drying and environment control. The latter refers to providing year-round comfort, including both heating and air conditioning not only of farm homes but also barns and other farm buildings. Better preservation of crops and increased output from farm animals would be achieved.

The artificial drying or curing of tobacco is already established, Flint said, and the volume of corn put through dryers is steadily increasing. Drying of hay and grain crops is under study, since it is recognized that controlled drying increases the nutritive and the monetary value of the crop. The crop-drying market would likely have to be shared with other petroleum fuels, primarily liquefied petroleum gas, he said.

Contributing to the future expanded agricultural market for middle distillates may be weed control, soil sterilization, and use of oil fogs to reduce loss of ground heat by radiation which causes frosts.

An interesting new development in a completely different field with high interest now is a snow-melting device which operates on fuel oil. One of several such devices is one being built and marketed by Thermal Research and Engineering Corp., based on original concept by Esso Research and Engineering Co. The latest model, mounted on a trailer for easy mobility and having a rated snow-melting capacity of 75 ton/hr, was demonstrated this past summer by Esso for New York City officials who are interested in its potential use to handle the city's huge snow removal problems every winter. An earlier, stationary version with a 25 ton/hr capacity, has been test operated the past two winters at the La Guardia Marine Air Terminal in New York. Its performance has been the equivalent of clearing 110 tons of snow from a 110,000 square foot area in a little over four hours. Fuel cost was $7.50 per hour, representing a savings over trucking the snow away of about $50 per hour, and completing the job in half the time trucking would have required.

Heart of the device is a tank in which water is highly agitated, and heated to 40 to 45 F by a principle termed "submerged combustion." Snow is dumped into the tank by front-end loaders; it melts almost instantaneously and the water drains into sewers at about 300 gal/min. It was estimated that New York City could quickly clear all its major arteries after a heavy storm with 30 to 40 such mobile snow melters. Less than two gallons of distillate fuel oil can melt one ton of snow. Water in the tank is heated by two, 60-gal-per-hour, high heat release oil burners.

Wide applications for either the mobile or the stationary models is seen in airports, parking lots, service stations, and shopping centers.

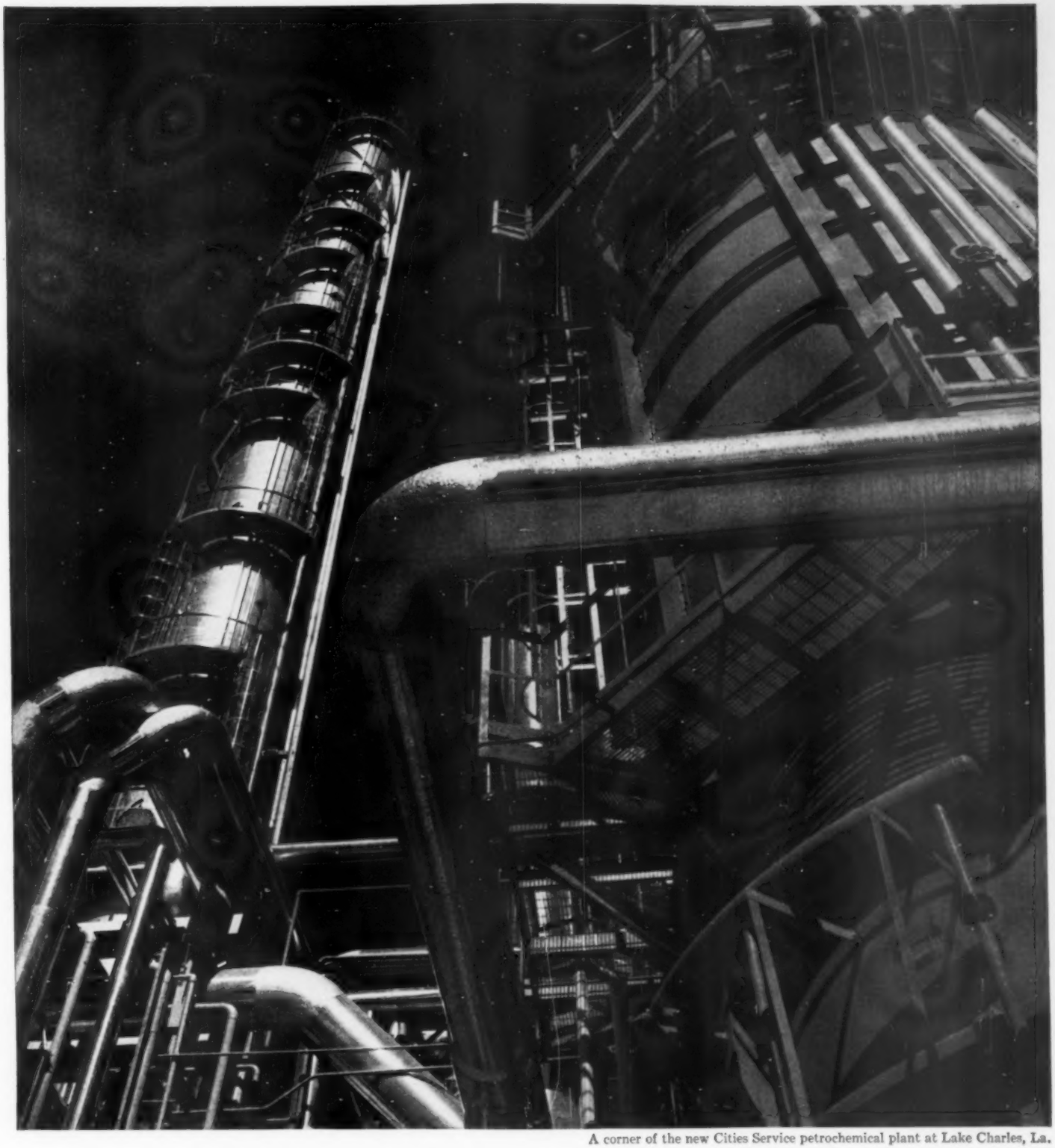
Somewhat further in the future as a new use for distillate fuel oil is the hydrocarbon fuel cell, now being studied in many research laboratories.

"We believe that, ultimately, a fuel cell can be made to work on a distillate fuel," R. L. Weeks, head of Esso Research and Engineering's market research division, told the National Petroleum Association in a meeting last year. The fuel cell seems to offer a unique chance to use middle distillates as the source of all energy in homes, he said, because its efficiency will be much greater than that available to the homeowner through purchased electricity.

The overall impact of the fuel cell on petroleum consumption is likely to be small, and it might result in either a slight gain or loss in consumption, according to Esso Research's vice president W. J. Sweeney. "For applications in which the fuel cell displaces some other device using petroleum fuels, consumption should decrease because of the inherently higher efficiency of the fuel cell," Sweeney said. "However, this loss is offset by three other factors. First, the fuel cell will probably require a higher quality fuel than the competitive device in most applications. Second, a successful fuel cell will also displace competitive devices now using other than petroleum-based fuels, thus expanding petroleum consumption. And finally, an efficient fuel cell should find new uses and applications where no competitive device now exists."

Heavy fuel oil in iron manufacture. Refiners have achieved important results in cutting their output of residual fuel oils, which sell at by-product prices, principally for power generation and space heating, where they compete with coal and natural gas. Refinery yields of this product have been steadily reduced and now are around 11% of crude processed. Demand in the

(Continued on page 84)



A corner of the new Cities Service petrochemical plant at Lake Charles, La.

Cities Service on the move

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CITIES SERVICE

USA product demand will rise 3.2%

TOTAL USA DEMAND for petroleum products will increase about 3.2% in 1962—to 10,168,000 barrels daily, according to the most recent estimate of the Ethyl Corp. This compares with a rise of 1.8% for this year over 1960, M. P. Murdock, Ethyl's vice president-sales, said in a talk in New York late in September.

Trends in demand for products are shown in the accompanying chart and table. Consumption figures for 1960 are based on complete data. The estimate for this year is based on seven months' actual consumption plus an estimate for the remaining five months. The 1962 forecast was prepared after discussions between Ethyl and companies representing more than 75% of the USA refining capacity.

Here are the trends for the individual products, as seen by Murdock:

Gasoline, the largest volume product, now accounts for nearly half of the oil industry's total sales and for more than half of its revenue. Various motor vehicles and airplanes account for 85% of its use; the remaining use is in non-highway engines.

At 4,186,000 b/d, gasoline this year will show an increase of only about 1%, the lowest rate of increase during the past five years. Several factors have caused this—among them the advent of compact cars, the switch to jets by commercial airlines, and a general low activity in business.

Next year demand should be improved, Murdock said, due in large part to better business and industrial activity. Consumption is expected to rise 2.8%, with more people with more cars and more money to spend on gasoline.

Kerosine has seen a tremendous growth in the last couple of years due to its use as fuel for commercial jet planes, which now accounts for about one-third of the total demand.

At 405,000 b/d in 1961, kerosine's rise is almost 12% over last year. The forecast increase in 1962 of 7.4% indicates that the aircraft changeovers are levelling off, but are by no means complete. Also, with improved business conditions, the airlines can be expected to carry more passengers and use more fuel next year.

Distillates, which include heating oils for homes, apartments, schools, and office buildings as well as diesel fuels, are the second largest volume product.

The increase this year of 1.4%, to 1.9 million b/d, is below the average for the past few years, and it reflects largely the continually increasing competition from natural gas as a fuel for home heating. The somewhat improved prospects for 1962 are seen by Ethyl as a result of improved business which will mean more sales of diesel fuel to railroads and bus and truck fleet operators.

Residuals include the heavy fuel oils used by industry, by public utilities to generate electrical power, and by steamships as so-called bunker oil.

Lower industrial activity, restrictions on heavy oil imports, and increased competition from both gas and coal have all had a direct effect on residuals' volumes, which were down 0.8% this year. Again, because of the brighter outlook for business and industry generally, residuals can be expected to increase a comfortable 2.4% in 1962.

The other products, which includes the more than 2,000 products made from petroleum, are seen as providing a continuing growth in an already healthy demand situation.

The substantial gain of 4.3% estimated for other products for this year is accounted largely for by rising consumption of LPG, of military jet fuels, and of feed stocks to serve the petrochemical field.

Although the USA oil industry has been facing—and still does face—a number of problems, Murdock said the outlook is for 1962 to be a good year.

Among the more serious problems that were faced this year were these:

(1) There has been an over-supply of crude petroleum both in the USA and in the rest of the world.

(2) The refining capacity in the USA is over-built, and is still ahead of current demand. This year, USA refineries will be operated at approximately 82% of their rated capacity.

(3) There has been a slowing down in the rate of growth of the demand for petroleum products, and particularly for gasoline and industrial fuels.

(4) The oil industry in the USA is facing increased competition from natural gas, coal, and low-cost foreign produced crude oil. END

Trends in USA Demand for Petroleum Products
(Figures in 1,000 b/d)

Product	1960	1961	% change	1962	% change
Gasoline	4,146	4,186	+ 1.0	4,305	+2.8
Kerosine	362	405	+11.9	435	+7.4
Distillate	1,874	1,900	+ 1.4	1,938	+2.0
Residual	1,531	1,518	— 0.8	1,555	+2.4
Others	1,764	1,840	+ 4.3	1,935	+5.2
Total	9,677	9,849	+ 1.8	10,168	+3.2

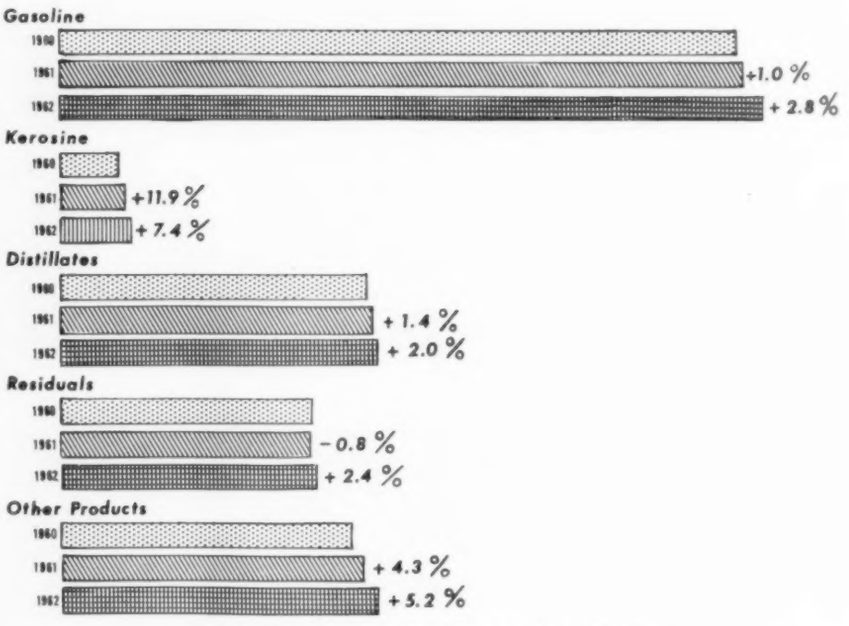

Fig. 1—Trends in consumption of products, USA, 1960-1962

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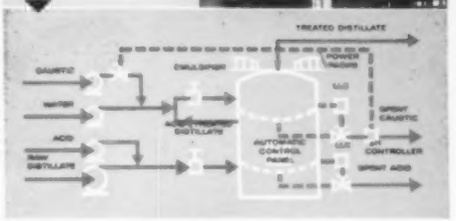
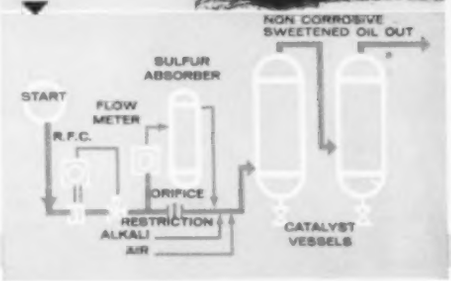
***ELECTROFINING** Precipitator flow diagram for typical acid-caustic treating.*



***BENDER** sweetening installation comprised of two sulphur absorbers and catalyst vessels.*

***BENDER** Catalytic Sweetening Process flow diagram.*



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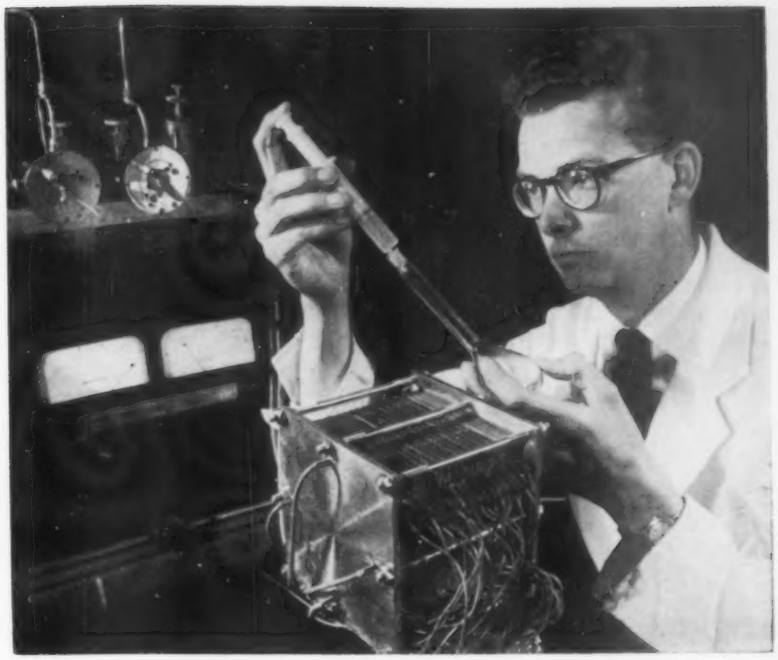
The advanced type of experimental fuel cell being studied at the Thornton Research laboratories of Shell Research Ltd.



The fuel cell — promise or threat to the petroleum industry?

by Eric Eltham

In the past fifteen years more new ways of tapping the world's vast sources of energy have been proposed and explored than in the whole history of technology.

One of the most intriguing of the new devices has been the fuel cell. But there are others too—the thermionic tube, the solar cell, the thermoelectric couple, and the magnetohydrodynamic generator, for example.

As purveyors of the most convenient and in most circumstances the most efficient and economic form of packaged energy, the oil industry has more than a casual interest in these exotic brain children of the new generation of scientists.

The fundamental question facing the industry is: Will these new energy producers contribute to the market for our products or will they compete with us?

In the case of the best known of the new energy sources—atomic energy—we already know that in the long run we face a competitor. For the rest of this century, however, barring any unforseen technical breakthrough, and provided oil remains readily available at the price bearing the same relation to other sources as it does today, we know that atomic energy will not even absorb the increments in the world's energy requirements.

Atomic energy plants such as those now being built could never be justified if it were not for the fact that they produce fissionable material for other purposes, and also serve as pilot plants for furthering our knowledge of atomic power plant technology.

But what is the future for the new, unconventional power generators such as the fuel cell?

Energy is another name for stored mechanical work. Every time we wind a watch we store mechanical work which is released in making the watch run. Most forms of energy employed by man are stored energy from the sun—including hydroelectric power and fossil fuels. Even the colossal energy of electrical storms is generated by the sun's heat.

Perhaps one of the few exceptions to this almost univeral rule is the energy in the trade winds which comes in part from the spinning of the earth. But the age of sail went out over a hundred years ago. Another exception is the energy stored in a dry cell; but the contribution of these tiny power packages to our energy requirements is virtually nothing, even though we must admit the convenience of the devices.

Conventional devices depend upon the release of the stored energy in fuels as heat. But there is waste, and losses, which contribute to low efficiency. A steam engine, for example, will always operate at less than 50% efficiency because of a funda-

The experimental farm tractor developed by Allis-Chalmers, powered by 1,008 fuel cells has 3,000 lb of drawbar pull

mental law of thermodynamics. Only if we could discharge the exhaust vapor at a temperature of -460 F would this step of our energy conversion process approach 100% efficiency. Clearly this is forever impossible!

And, in the use of hot vapor or gases to drive a piston or a turbine, we encounter losses due not only to the dissipation of heat but also those resulting from friction. An automobile engine, for example is able to use perhaps only 15% of the energy in the fuel; a steam locomotive 8%; a diesel locomotive 25-30%; and a large electric generating plant 40%.

One reason for the current rash of activity in the development of new sources of energy is that some of them will permit us to avoid the wasteful conversion of the chemical energy in the fuel to heat energy and thence to mechanical energy.

One of them—the fuel cell—promises to free us from the limitations imposed by the laws of thermodynamics. As a result, with the fuel cell, theoretical efficiencies of 100% are possible, although from a realistic point of view 70% is what is being aimed at with this particular generator.

This power package is of the greatest interest at the moment to the petroleum industry, not only because there is the promise that it can use petroleum derived fuels but also because it may offer a means of producing petroleum derived chemicals of very high purity.

The requirement for a light, portable, quiet, non-exhaust producing electric generator has been the space programs. Such a device, it is worth noting, could be bought for a few pennies at every drugstore. This is the ordinary dry cell used in flashlights and small radios.

If the dry cell actually did meet exactly the above requirements, the almost crash program on fuel cell development would not exist. Actually, however, the dry cell has a low power output, is relatively heavy, has a short life, and uses expensive materials or fuels. The terms "fuels" is used deliberately, because a dry cell is a fuel cell in that it consumes a material, usually zinc, to produce an electric current.

The recognized concept of a fuel cell is a device that literally burns a combustible fuel, without the formation of heat; all the energy of combustion being turned into electricity.

Like all ideas, the idea of burning a fuel without heat to give electricity is not new. As long ago as 1839, the English scientist Sir William Grove "burned" hydrogen and oxygen without heat to produce electricity and water. His work has been revived today, and cells employing his principle are being used as portable power packages by the military services.

But the goal is to use ordinary fuels like natural gas, liquefied petroleum gas and kerosine in place of hydrogen, and air in place of oxygen. Fuel cells are running on these fuels, but their output is low and life short; or else they are too large and complicated and employ temperatures and pressures that are too high. By contrast, Union Carbide has built fuel cells that use hydrogen and air, operate at atmospheric pressure, and have run for two years without any trouble. These are used to power portable radar sets of the U.S. Army.

Hydrogen, however, is not a practical fuel. It is expensive—about $1 per pound. It has to be carried about in heavy pressure vessels. And, its availability is limited. The very weight of the pressure vessels destroys whatever advantage would be gained by the lightness of the power plant itself.

Research, therefore, is largely directed toward improving the appetite of the fuel cell for more conventional fuels. And this is, of course, where the petroleum industry enters the picture. As a marketer of packaged energy, it is vitally interested in new applications for its products. If the portable fuel cell—be it for driving vehicles or for small power generators—is to be practical, it will need a petroleum-derived fuel.

Thus, companies such as Esso, Texaco, and Shell are taking long and hard looks at this device in their research laboratories.

A demonstration of what may one day be practical is a tractor built by Allis-Chalmers which operates a two-bottom plow. It is powered by a battery of 1,008 fuel cells operating on hydrogen and oxygen.

Credit for focusing the attention of the scientific world on the possible utilization of the fuel cell as a power generator goes to Francis T. Bacon of Cambridge, England, who for almost 30 years has been experimenting with cells using hydrogen and oxygen. A license to manufacture the Bacon cell has been taken by a company in the USA and it has supplied a number of units to the U.S. Air Force.

In order to boost the output of his cell —it can deliver up to 300 amps but only a fraction of a volt—the Bacon cell employs temperatures of about 200 C and pressures up to 600 psi. This means the device is bulky, and as a matter of fact the control cabinet occupies more space than the fuel cell itself. Nevertheless, this cell can deliver 15 times more energy per pound of weight than a lead-acid storage battery like that used in an automobile.

Because of its inherent lightness, the fuel cell is being widely considered for such uses as a portable power plant for radar sets, power generators for space vehicles and for road vehicles. Therefore high pressures, high temperatures, and unconventional fuels are to be avoided if possible.

At the present stage of the art, the fuels that will react most readily at room temperature are hydrogen and oxygen, and most authorities feel that the utilization of

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* *"Synoptic meteorology is a weather-reporting technique based upon the collation and comparison of simultaneous reports from different areas."*

hydrocarbon fuels will depend upon their first being cracked to give hydrogen and carbon monoxide which will also react in the cell to give a flow of current.

An example of a high pressure, high temperature cell employing petroleum hydrocarbons in this way is the Sondes Place cell, developed in Great Britain by the Sondes Place Research Institute under contract to the Ministry of Power with the support of Shell. In Britain, Shell's Thornton Research Centre has devoted considerable effort to exploring the possibilities of the low pressure, low temperature fuel cell, the ultimate aim being to assess the adaptability of this type of cell to hydrocarbon fuels.

How far work has progressed with hydrocarbon fuels has not been disclosed, but from what Shell has published it appears it has made significant contributions to the technology of low temperature cells employing hydrogen and air. The Thornton cell employs highly active electrodes, and it can generate from three to five times more power per unit volume than similar cells under development.

Fuel cells of the non-portable type are receiving considerable attention from public utility companies. For example, they offer an attractive possibility for converting natural gas into electricity at a high degree of efficiency. More importantly, they offer the power companies a chance to overcome the necessity of installing up to twice the average capacity needed in order to be in a position to meet peak demand.

Proponents of the fuel cell advocate running smaller generating plants at full capacity 24 hr/day, the most efficient method of operating a power plant. When demand is low, the idea is to use the surplus power to convert water, by electrolysis, to hydrogen and oxygen, which can be stored. Dur ing hours of peak demand, the hydrogen and oxygen would be fed to a fuel cell where they would furnish electricity in recombining to form water. This proposal, it should be noted, promises to make nuclear power plants at least twice as economically justifiable as they are now, it could be one of the "technological breakthroughs" referred to at the start of this article.

Two factors have to be borne in mind in the use of fuel cells to generate electric power. First, cells generate very low voltages; and while they can be connected in series, there is some question whether they can be multiplied in units in excess of 700 volts, because of insulating problems. Secondly, since they are batteries they produce only direct current while most distributing systems employ alternating current. This latter difficulty can no doubt be overcome by converters.

On the other hand, fuel cells generate very high currents—a single cell generating up to 300 amps. Because direct currents of high capacity are needed in the electrochemical industry — for example, refining of aluminum—the generation of electricity from fuel cells, powered say by natural gas, could change the entire pattern of the electrochemical industry, which now is largely grouped near sources of hydroelectric power.

There is another facet to the fuel cell besides its energy possibilities. In producing power, chemical reactions are also taking place. The end product of the hydrogen/oxygen cell is, of course, water; but a cell operating on wood alcohol produces formaldehyde, and if ethanol is used the result is acetaldehyde.

Many other possibilities exist for producing chemicals of extremely high purity. Although the power produced during the reaction might not be of commercial value, it could nevertheless be used to augment the power supplies of the installation. In fact, at this stage of development of the fuel cell, no one can say whether its future lies in producing power or in being a chemical plant.

Now let us take a brief look at some of the other energy generators now under intensive study in several research laboratories.

The solar cell is another name for the photoelectric cell. A material called a semi-conductor, and usually derived from silicon, is activated by sunlight (though artificial light can be used), and as a result a current will flow if the cell has been connected to an electric circuit.

The most familiar form of this cell is probably to be found in the photographer's light meter. However, the energy produced by such a cell is infinitely small, and as a power source it would be hopelessly inefficient. On the other hand, for space research these devices promise a simple method of trapping energy from the sun; and our artificial satellites already employ them to provide power for their instruments.

Last year, an automobile employing a thousand or more of these cells was demonstrated. But this was a publicity stunt, and demonstrated no practical use for the devices, particularly in England where it had to run on power captured by its cells in America.

Solar cells may be useful in space research, but they will never be a serious contender as a significant supply of the world's energy. Obviously, they use no conventional fuels.

Thermoelectric generators turn heat directly into electricity without any moving parts. They are really improved versions of the thermocouple, a device made by joining two wires of dissimilar material. When one of the junctions is heated, a current will flow. The Russians have built thousands of radio sets which are powered by one of these devices using a kerosine lamp as the heat source.

The U.S. Navy is very interested in thermoelectric generators for powering ships, and has entered into research and development contracts with firms like Westinghouse, Carrier, and Radio Corp. of America to develop a 1,000-KW generator. At the present stage of the art, these devices are very inefficient, and will remain so until suitable materials for their construction are found.

Eventually, they may be able to convert heat into electricity at an efficiency of about 30%—nothing very startling—but because they use no moving parts like costly generators do they offer interesting possibilities as a capital investment.

For military purposes, their freedom from noise and vibration is a great asset. Since they rely on a source of heat for their operation, they can employ petroleum fuels, though of course other heat sources such as atomic energy are under consideration.

The thermionic tube is another device to transform heat directly into electricity. It has been considered as means of tapping some of the waste heat in the exhaust of rockets to provide electrical power to operate the controls of a space vehicle.

It relies on the fact that certain materials give off electrons when they are heated to about 3,000 C. These electrons are caught by an electrode and made to flow through an electrical circuit.

The most interesting proposal for the thermionic tube is to make it an integral part of an atomic power generator, the uranium rods in the pile being the source of electrons. This would simplify atomic power generation by doing away with the electric turbine and the fluids—i.e., pressurized water and steam—to drive it. Perhaps a thermionic tube in an atomic pile could increase the efficiency of electrical power output from 30 to 45%.

Magnetohydrodynamic generators. Of all the exotic energy producers, this is probably the most daring, and the most difficult to reduce to practicality. But the rewards offered are great. Perhaps it will make possible the boosting in efficiency of a central electric power station to 60%. And, it is of especial interest to the petroleum industry because it could operate on petroleum fuels.

Basically the MHD generator is an electric dynamo that uses a stream of hot gases moving at high velocity through a magnetic field in place of a complicated arrangement of rotating wires between the poles of a magnet.

The major difficulty with this device is that the gases have to be heated to 3,000 C, a temperature at which most materials—including the best refractory bricks—melt. To make the gases conducting, they are "seeded" with charged atomic particles, or ions. Once the gases have passed through the magnetic field, they enter a heat exchanger, where the heat is removed to drive a turbine.

Thus far, MHD generators are laboratory toys, consuming two or three times the power they produce. However, the power companies, Westinghouse, Avco, Lockheed, and some of the oil companies are carrying on studies that could lead to a large step forward in the efficiency of power generation. The tremendous strides being made in our knowledge of materials of construction lends support to the prediction that a large MHD generator will be operating in 10 years.

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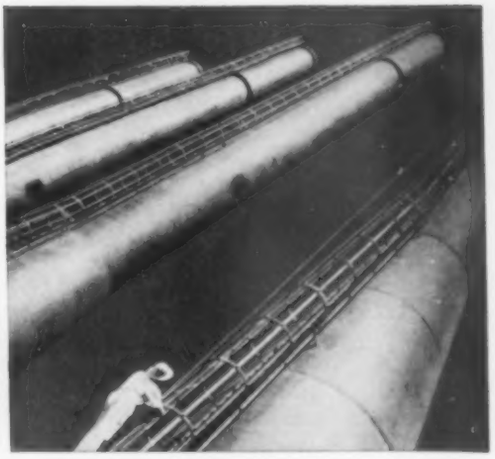

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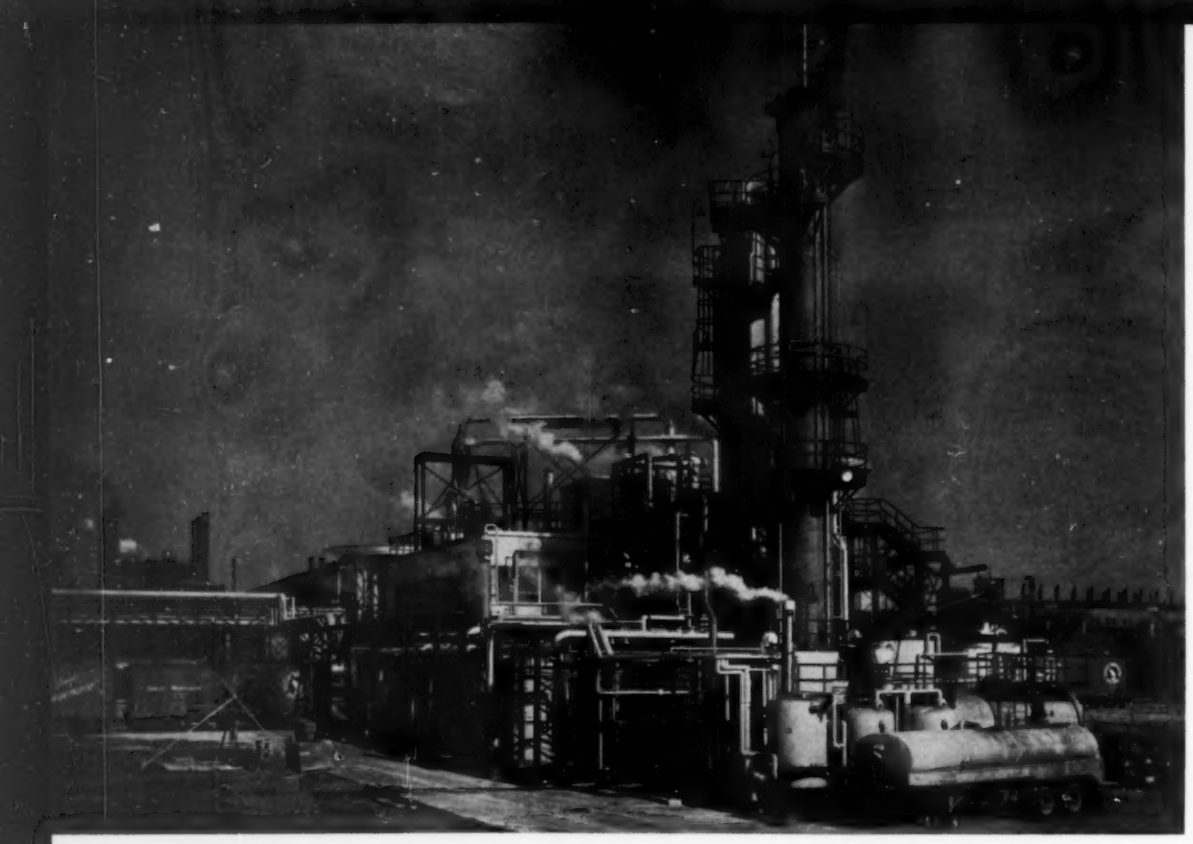

Plant for production of adipic acid from phenol-based cyclohexanol, operated by National Aniline Division

Air oxidation of cyclohexane

by Peter W. Sherwood
Chemical Engineer, White Plains, N. Y.

CYCLOHEXANOL AND CYCLOHEXANONE enjoy a key role as intermediates in the production of adipic acid and caprolactam, raw materials for the two major commercial nylon types. They are produced today from two raw materials: phenol and cyclohexane. Economic considerations and recent technological developments make it most probable that future growth of cyclohexanone capacity will be based predominately on the air oxidation of cyclohexane.

A quantitative determination of the future growth outlook for cyclohexane oxidation depends on the interrelationship of a number of factors; notably expansion of demand for adipic acid and caprolactam, impact of competitive routes for the synthesis of these intermediates, and changes in the raw materials position for cyclohexanone production. Before discussing the technical aspects of cyclohexane oxidation, it is therefore in order to consider briefly some of these economic relationships.

1. Adipic Acid

Consumption of adipic acid in the USA has grown from 50 million lb in 1950 to 326 million lb in 1960. The overwhelming share of this market (approximately 290 million lb) is accounted for by the manufacture of nylon-66, a copolymer of adipic acid and hexamethylene diamine.

Direct consumption of adipic acid per 100 lb nylon-66 is 65 lb. But beyond that, much of the hexamethylene diamine is also made from adipic acid—via adiponitrile.

Compared to this use, other end uses of adipic acid are relatively insignificant. Overall distribution pattern for 1960's total consumption of 326 million lb has been estimated as follows[12] (in million lb): nylon-66 manufacture, 290; adipate plasticizers, 18; polyesters for urethane foam, 8; synthetic lubricants, 4; and others, 6.

Analysis of the future growth prospects for adipic acid is complicated by various competitive influences. Hexamethylene diamine, manufactured by Chemstrand from adipic acid, is also obtained from furfuraldehyde and from butadiene. There are indications that future expansion will look mostly to the butadiene route, while the furfural route is on the way out. Nor is it at all clear how future sales of nylon-66 will be influenced by nylon-6, which has grown rapidly since its introduction in the United States in 1955.

Adipic acid is produced by the nitric acid oxidation of cyclohexanol, either as such (produced from pehnol) or in mixture with cyclohexanone and several by-products obtained as crude product in cyclohexane oxidation. Cyclohexane is the predominant new material for adipic acid production in the United States, where it serves as raw material at the following plants (capacities are in million lb/yr of adipic acid): Chemstrand, Pensacola, Fla., 200; DuPont, Belle, W. Va., 200; and Rohm and Haas, Louisville, Ky., 20.

Construction plans were announced in June, 1961, for the Rohm and Haas plant. Indications are that this plant will use air, rather than nitric acid to convert cyclohexanone-, ol mixture into adipic acid.

Several processes have been developed which would substitute air for nitric acid in the conversion of cyclohexanol-cyclohexanone mixtures to adipic acid (e.g.[10]). Still other methods seek single-stage air axidation of cyclohexane to adipic. None have so far become commercial.

2. Caprolactam

Caprolactam is, above all, the intermediate for nylon-6. USA capacity for this polymer in 1960 was 48 million lb, and is now being rapidly expanded. European output of nylon-6 greatly exceeds these volumes. While market figures are not available, production facilities for nylon-6 make up a major percentage of the 300 millon lb/yr, polyamide fiber capacity which was on stream in western Europe during 1960.

As yet, nylon-6 has found little use in USA-made cloth but it is claimed that the newer product is potentially cheaper than

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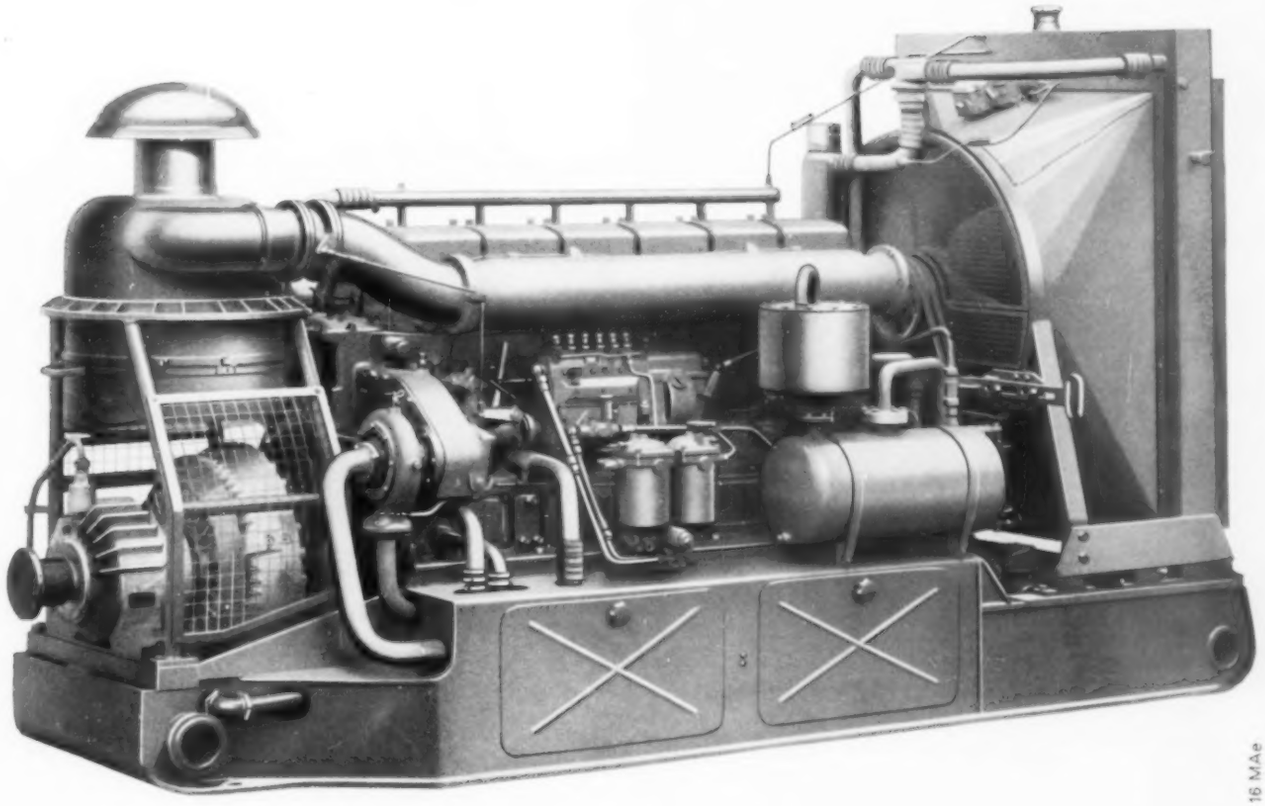

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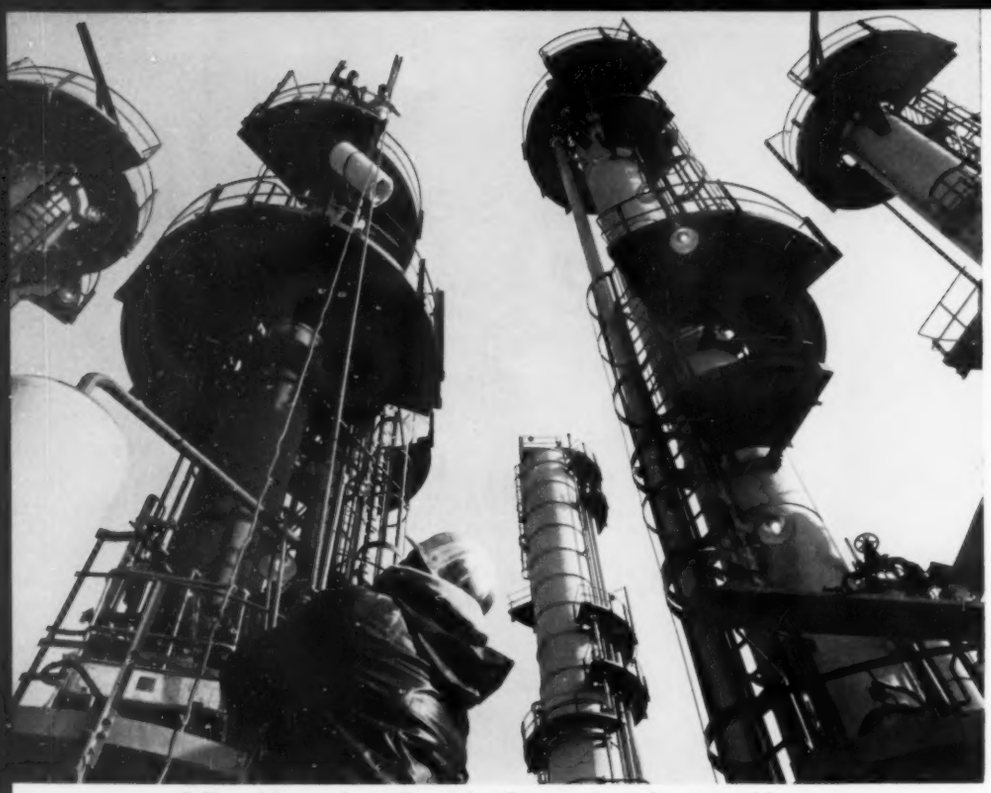

Gulf's cyclohexane plant at Port Arthur, Texas, employs hydrogenation of benzene

nylon-66. Certainly, it has found wide application in European-made garments, although USA demand for nylon-6 is still concentrated on such specialty uses as tire cord and carpeting.

In the light of the favorable outlook for nylon-6, caprolactam capacity is being rapidly expanded. According to one source,[16] USA demand for caprolactam is expected to be 165 million lb in 1963, but this is probably a high estimate. Capacity on stream by mid-1962 will certainly be in excess of 160 million lb/yr.

Several processes for caprolactam production are commercially significant. As of early 1961, the bulk of world output was made from phenol-derived cyclohexanone. Specifically, cyclohexanone is reacted with hydroxylamine sulfate to yield cyclohexanone oxime, and this product is shifted, via a Beckmann rearrangement, to caprolactam.

Several recent developments have brought competitive caprolactam syntheses into the picture. The following are of particular significance:

(1) Construction by DuPont of 50 million lb/yr caprolactam plant at Beaumont, Texas, in which cyclohexane is nitrated to nitrocyclohexane which is then reduced to caprolactam. Although details of the process have not become known, a related approach developed by BASF involves reduction of nitrocyclohexane by ethylene, yields ethylene oxide as co-product.[17]

(2) Construction of caprolactam facilities by Snia Viscosa (Italy), Allied Chemical (U. S.) and Courtaulds (England) in which caprolactam is obtained from toluene via hexahydrobenzoic acid. This process, developed by Snia Viscosa, has been described by the author previously.[18]

(3) Development of a photochemical synthesis of cyclohexanone oxime from cyclohexane and nitrosyl chloride. This is not yet a commercial method, but a potentially useful process involving this technique has been developed in Germany[19] and piloted by Toyo Rayon in Japan. A variety of additional developmental processes have been described privously in this journal.[17]

With these exceptions, cyclohexanone serves as intermediate for caprolactam synthesis in all commercially interesting processes. Most recently, this approach has been selected for a 33 milion lb/yr caprolactam plant in England, announced by ICI. This unit will utilize cyclohexane oxidation as intermediate step. Its process basis will be knowhow developed by Emser Werke AG/-Inventa AG.

Indications are that future caprolactam expansion generally will favor the use of cyclohexane as raw material for caprolactam-grade cyclohexanone. By 1962, air oxidation by cyclohexane will be practiced at the following caprolactam plants:

Plant	Country	Capacity (Million lb/yr)
BASF	Germany	110*
Dow-Badische	USA	44
ICI	England	33
Toyo Rayon	Japan	22
		209

*Being expanded from 77.

The chief reason for the coming ascendancy of cyclohexane over phenol as raw material for cyclohexanone is the advantage in raw materials cost. A comparison to the newer toluene-based synthesis of Snia Viscosa cannot yet draw on commercial operating data. However, it should be pointed out that the latter method will presumably enjoy a strong patent position and that it is accompanied by the formation of large amounts of ammonium sulfate (about 4.5 lb per lb caprolactam) so that the achievable ammonium sulfate price has major influence on caprolactam economics.

Cyclohexane vs. Phenol

Cyclohexanol and cyclohexanone may be produced by the direct oxidation of cyclohexane. The alternative approach is the hydrogenation of phenol to cyclohexanol followed by the latter product's dehydrogenation to the corresponding ketone. Both routes are employed commercially. Cyclohexane oxidation is today by far the more important method (in the United States) of cyclohexanol and cyclohexanone production, when these compounds are to serve in the manufacture of adipic acid. In this case, the alcohol and ketone are not purified. Instead, the crude oxidation mixture, which also contains significant amounts of adipic acid and other by-products is charged directly to a nitric acid oxidation stage for conversion to adipic acid. At this writing, an estimated 85% of adipic acid production in the United States is based on cyclohexane.

An entirely different picture prevails in the production of cyclohexanone for manufacture of caprolactam. Here, it is necessary to achieve high purity (above 98.5%) in the cyclohexanone product, and this is attained more easily by the conversion of phenol. Furthermore, phenol conversion is accompanied by formation of only insignificant quantities of by-products, while cyclohexane oxidation necessarily yields a number of products which are useful in adipic acid synthesis, but cannot enter into the manufacture of caprolactam. For these reasons, the bulk of present caprolactam production is based on phenol. However, as noted above, the current trend here, too, is toward cyclohexane as raw material.

From a quality point of view, cyclohexanol produced by todays cyclohexane oxidation technology and recovered in the course of simple fractationation is found to be as suitable for dehydrogenation to cyclohexanone as is the alcohol derived by the hydrogenation of phenol. Furman[1] has compared the relative performance in the dehydrogenation of cyclohexanol stocks obtained by these two different routes, with the following results:

Zinc-iron-catalyzed dehydrogenation of cyclohexanol derived from phenol and cyclohexane, respectively

	Cyclohexanol derived from	
	Phenol	Cyclohexane
Concentration of ketone in dehydrogenation product, %	82.5	86.8
Conversion of cyclohexane, %	83.7	89.9
Formation of by-products, %	1.1	1.2
LHSV of feedstock, hr[1]	1.10	1.17
Linear vapor velocity, m/sec	0.78	0.16
Residence time of vapor in reactor space	7.6	8.4

(Continued on page 90)

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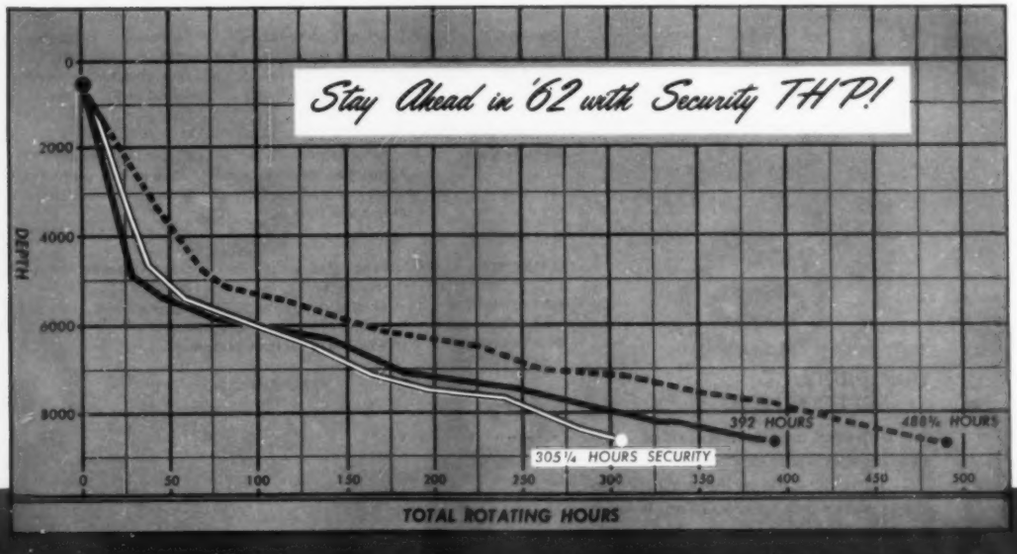

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New Uses, Wider Markets

(Continued from page 68)

USA for residual fuel oil has changed little over the past decade, as shown in Fig. 1. Less is produced in this country than today's demand; imports supply a large share of requirements.

An important development which promises a new wide-scale use for heavy oil is in replacing at least a part of the coke (from coal) used in blast furance operations. This represents a market estimated at over 100 million bbl per year by 1970. Details of the method have been discussed previously in this magazine (see WORLD PETROLEUM, Dec., 1960, p. 80; and October, 1961, p. 64).

Should this new technique be widely adopted in iron making, another petroleum market would also benefit; namely, the market for some of the large volume petrochemicals. About $300 million worth of benzene, naphthalene, and other chemicals are now being produced in the by-product ovens that convert coal to coke. These chemicals are now supplied in part from petroleum sources. Supplies from this source would have to be greatly increased were the output of coke ovens reduced.

Research in both the nature and properties of products and in oil consuming devices is now established as the key to new markets for petroleum. Present technological and economic conditions lend impetus to the studies already being carried on, to the logical end that the utilization of petroleum will be further expended in coming years. END

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New Steel for Gas Lines

Working in a refrigerator, a welder proves out the physical properties of a new columbium-additive steel that enables it to bring all-weather field weldability, higher strength thinner-wall pipe and substantial cost savings to the building of larger capacity natural gas transmission lines.

The 24-month project has just been completed as a joint venture to advance the science of pipeline construction by Natural Gas Pipeline Co. of America, Chicago; A. O. Smith Corp., Milwaukee, and National Steel Corp.'s Great Lakes Steel division, Detroit. It covered design, engineering, metallurgical and cost studies of the new steel—labeled XC-60—from open-hearth making to pipe fabrication and through field installation of a 47-mile 20-inch diameter line in Texas for evaluating performance in actual gas transmission service.

Use of the columbium-additive steel in the 47-mile line resulted in estimated $1,000 per-mile savings, by comparison to stablished average cost patterns for X-52 grade pipe steels, the highest strength grade now in general use for cross-country pipe line application.

World Petroleum Index Available

Copies of the Editorial Index for WORLD PETROLEUM for 1960 are still available, and may be obtained by writing to: Readers' Service Department, WORLD PETROLEUM, 25 West 45th Street, New York 36, N. Y.

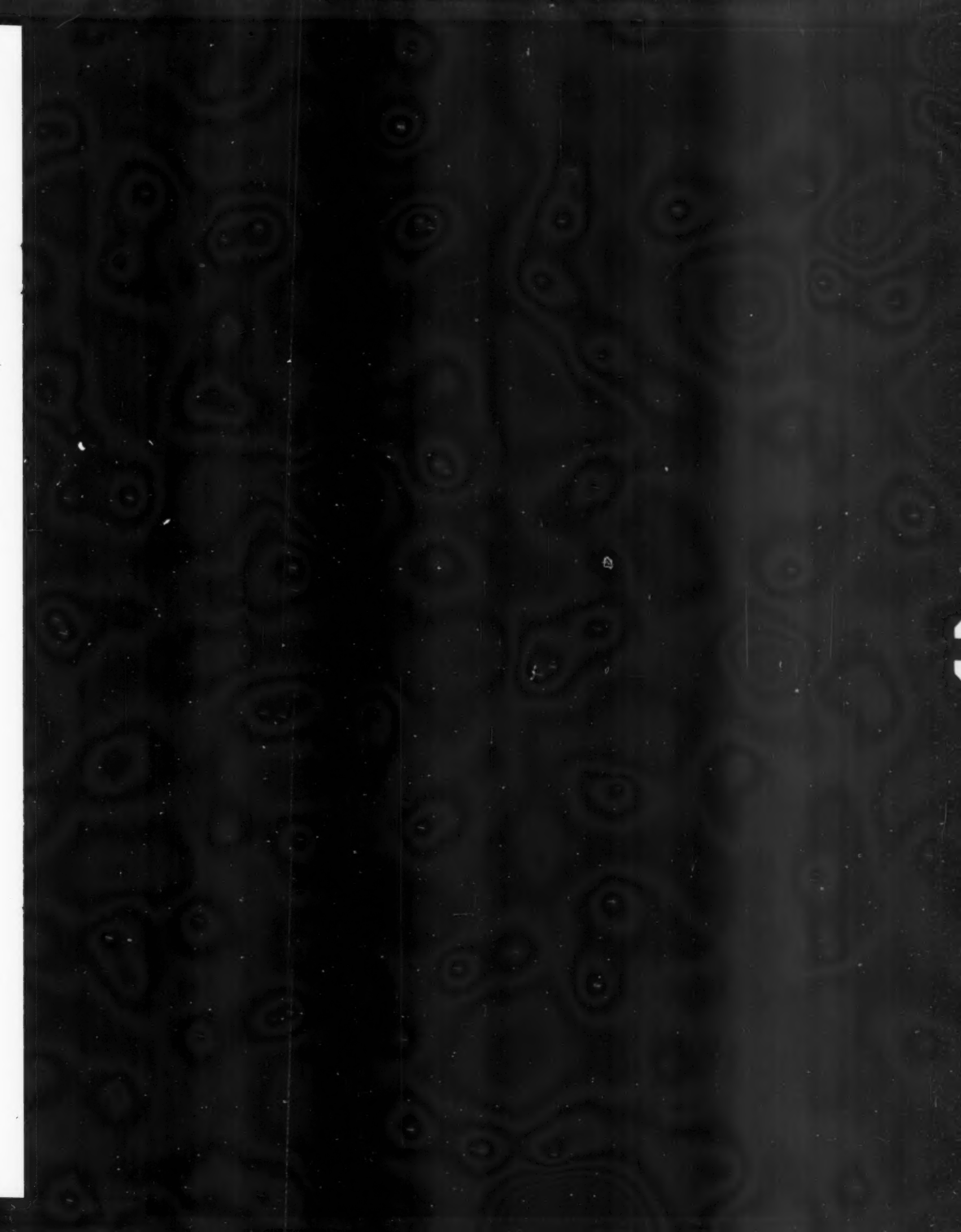
Halliburton's New UK Plant

Part of a new industrial complex now growing in Suffolk County, England, is the new Halliburton, Ltd. factory that went into operation in early 1961. The plant now employs over 30 persons and company officials predict a steady increase in employees over the next few years.

Halliburton, Ltd., a subsidiary of Halliburton Co., Duncan, Okla., is in charge of Haliburton's oil well servicing operations throughout the sterling area. London is headquarters for Halliburton, Ltd., where the resident manager is J. K. Reynolds, who has been with Halliburton 23 years and has worked in the firm's foreign operations since 1951.

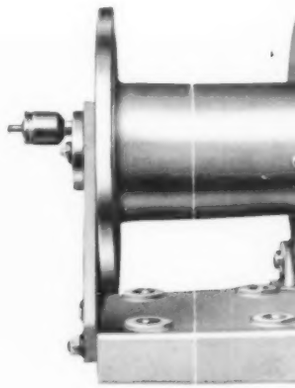
Manufacturing operations at the new plant are being supervised by Edwin T. Kaltwasser, assistant manager of Halliburton Ltd. and manager of the Haverhill plant, and Daniel P. Green, assistant plant manager.

The Haverhill plant is on a three acre site and covers 18,000 sq ft of shops, warehouse, and offices. It incorporates a machine shop, welding shop, sheet metal working shop and has facilities for fabricating all Halliburton's rolling and bulk cement handling equipment.



Portable Air Compressors, Air Motors, Air Winches,

" Think big, think safely, think well ahead " summarises the rules that apply to all planners in petroleum . . . to planners and executives at refineries particularly. Compressed air is the safest form of power to use among highly inflammable products. The Holman Group is the largest manufacturer of pneumatic equipment in the British Commonwealth, and 70 per cent. of HOLMAN output is exported. Air compressors, percussive tools, air motors, air winches, submersible pumps and other pneumatic equipment manufactured by HOLMAN have earned a reputation for safety, efficiency, and high performance with low operating and maintenance costs.



ROTAIR Portable Rotary-screw Air Compressors

Over-all efficiency and negligible maintenance costs are important features of ROTAIR compressors. There are no reciprocating parts: vibration is minimised. Positive clearances prevent metal-to-metal contact both between the rotors and the stator casing; which is subject to no wear whatever. ROTAIR models deliver 150, 370, and 600 cu. ft. min. F.A.D. at 100 p.s.i. Stationary models are also available.

Catalogue RO 2

HOLMAN also manufacture portable reciprocating compressors in which detailed attention to valve design, and the use of double-acting differential pistons, contribute to long life and efficiency. The range includes three water-cooled and two air-cooled models with capacities from 120 to 315 cu. ft. min. at 100 p.s.i.

General Catalogue, Section A 2

TRACTAIR and HOLPACK Portable Air Compressors

For on-the-spot manœuvrability, HOLMAN offer a choice of tractor-mounted air compressors. Tractair Models 8 and 13 comprise self-contained HOLMAN two-stage compressor units mounted on Fordson Major tractors and driven from the power take-off shaft. Holpack Air Compressor assemblies are suitable for attaching to tractors which have hydraulic or power-operated lift linkage. The Holpack can be lifted bodily and taken to the work site. If the tractor is required for other work it can be detached in less than two minutes. Tractair and Holpack Models 8 and 13 have outputs of 71·5 cu. ft. min. and 110 cu. ft. min. F.A.D. at 100 p.s.i. respectively.

Leaflets A 5, A 6, A 7, A 8 and A 9

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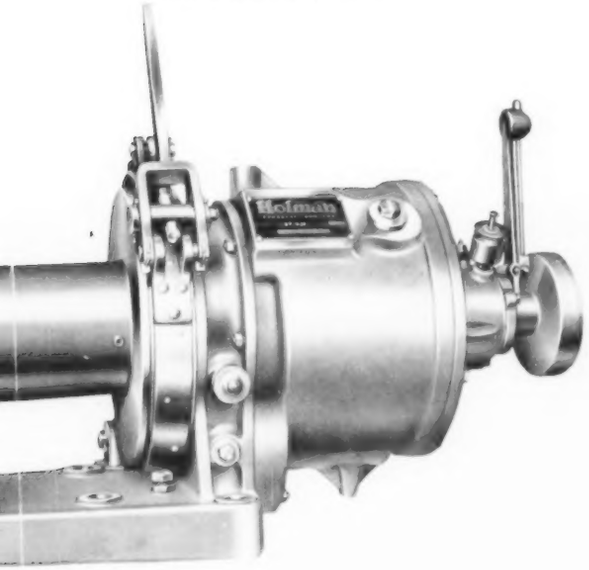
Compact, robust, powerful and safe means of handling heavy loads of all kinds. HOLMAN Air Winches range in power from 5 to 15 h.p. The ROTOWINCH is powered by a reversible motor capable of a rope pull of 4,000 lb. at 120 ft. min. rope speed. HOLMAN Cable Winches have high torque at low speeds and rope pulls of from 4,260 lb. to 5,000 lb.

General Catalogue, Section B 1



HOLMAN Road Rippers

From a light-weight model for use at unusual angles without fatiguing the operator, to a heavy-weight capable of breaking the hardest concrete aggregate, the HOLMAN range of road rippers is unbeatable for power weight ratio. These machines will outperform any other road rippers of comparable air consumption and weight. A full range of steels and other implements is available. The SS 80 Road Ripper illustrated is the most powerful of the HOLMAN range. It is available with spring or latch-type retainer and weighs 80 lb.

General Catalogue K 2, and Publications SP 17 and SP 30

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HOLMAN Submersible Pumps

Centrifugal, self-priming, submersible pumps for handling water, oil, sewage and even moderately heavy sludge. Single-stage models can cope with heads to 100 feet. For heads from 120 feet to 240 feet there are two double-stage models. All submersible pumps have specially designed vane-type air motors.

General Catalogue, Section K 11

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General Catalogue, Section K 11

GRINDEX Hydromaster Submersible Pumps

Centrifugal pumps with 3-phase squirrel-cage motors for continuous operation, are intended for pumping out foundation sites, flooded areas, and for coping with large quantities of water. GRINDEX Minor and Standard pumps are rated at 220 and 320 I.G./min. respectively at 30-feet head. These pumps can be coupled in series for increased lift, and they can operate dry without damage.

Publication: Grindex Hydromaster Leaflet

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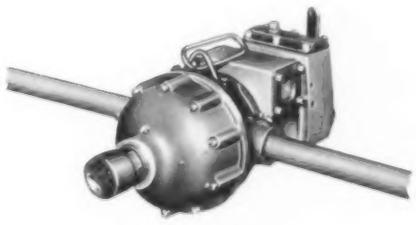
General Catalogue, Sections S 1, and Leaflets STV 1, 2 and 3



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General Catalogue, Section K 12

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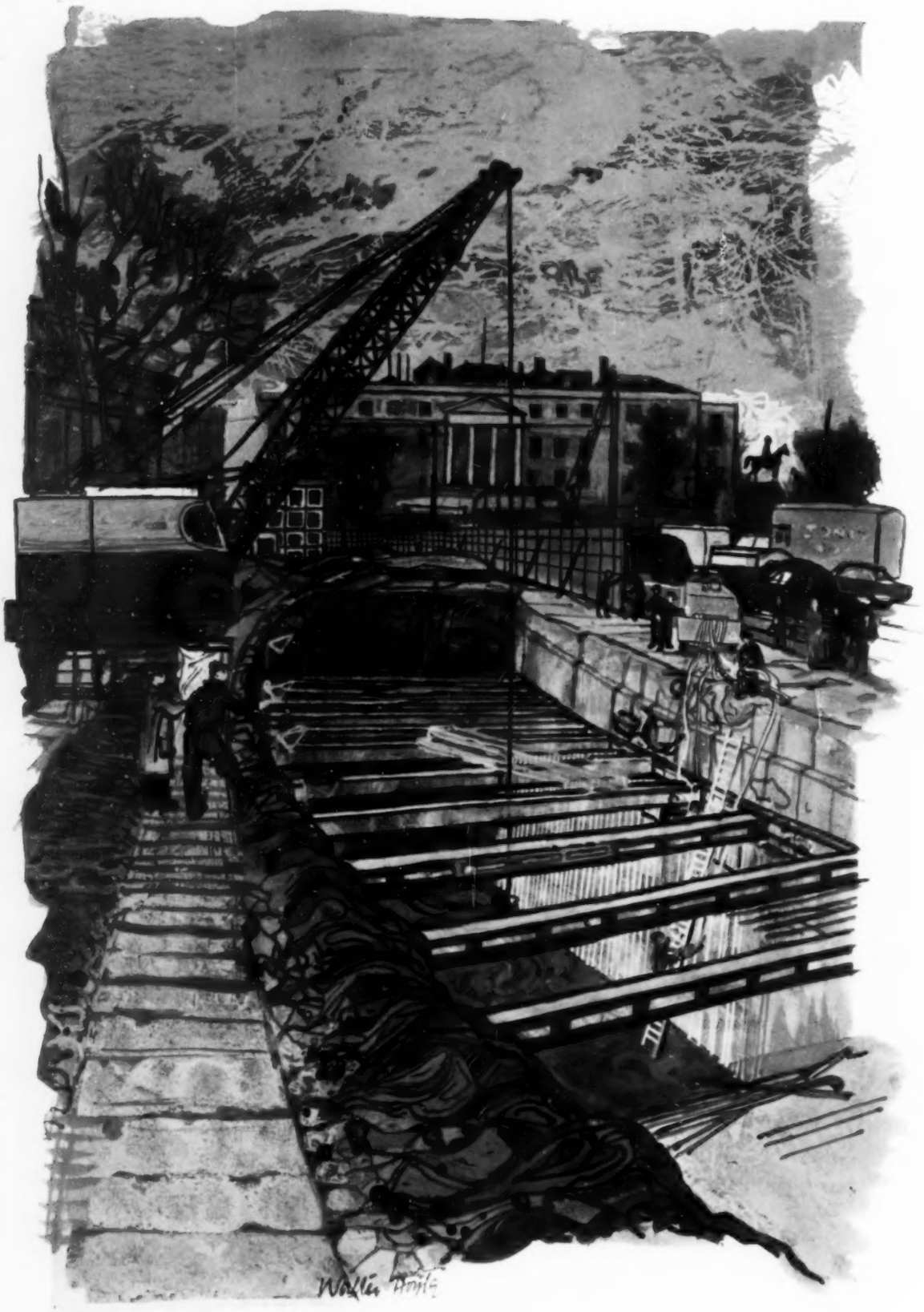

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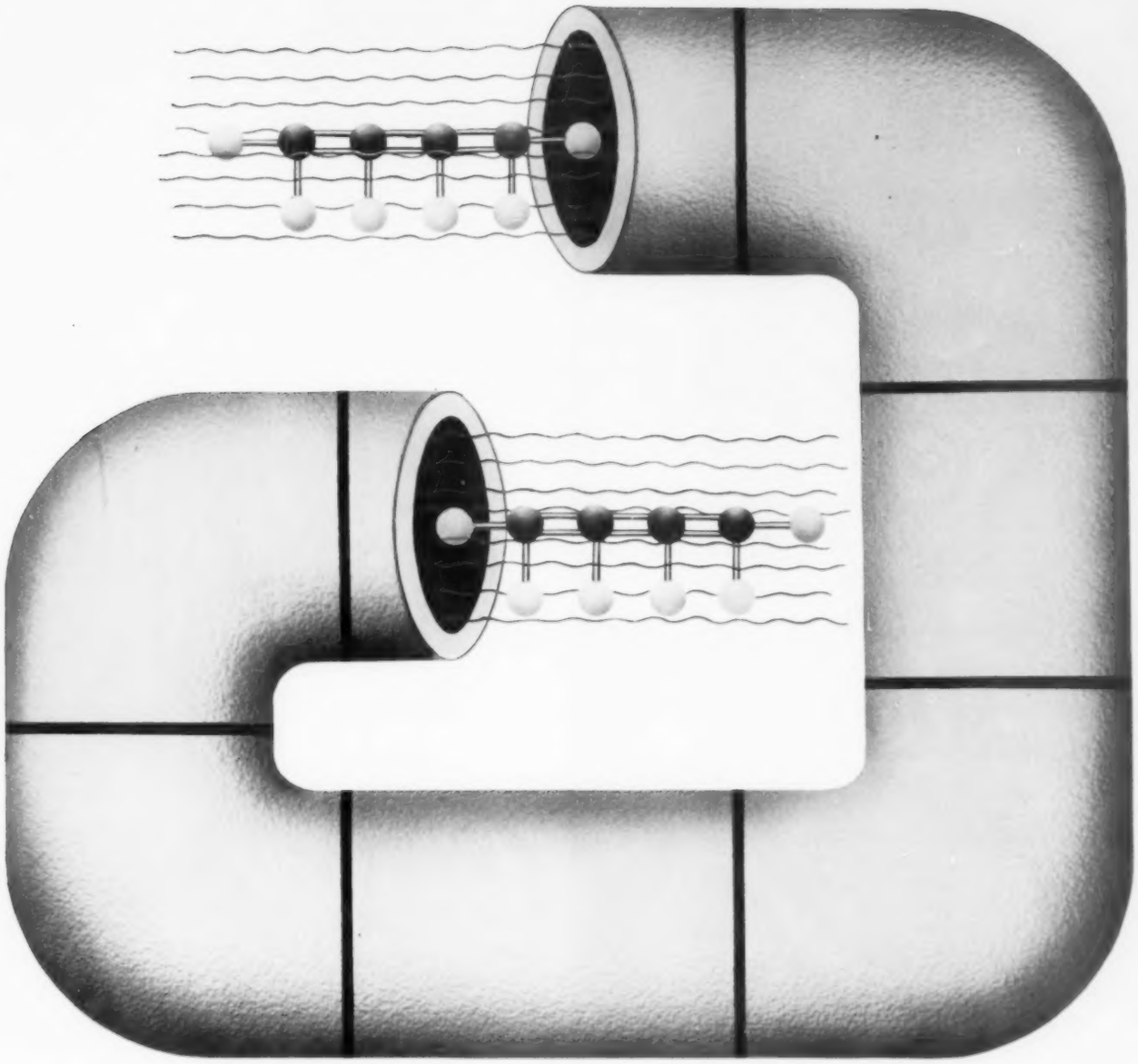

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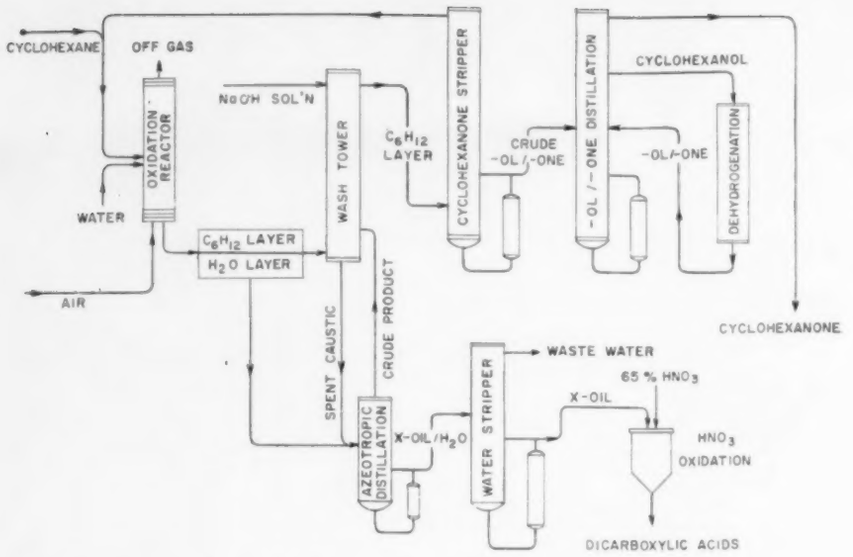

Fig. 1—Flow sheet in production of cyclohexanone from cyclohexane

Cyclohexane Sources

The rapidly growing demand for cyclohexane is currently supplied in the United States by Continental, Gulf, Phillips, and DuPont (captive use), with a combined cyclohexane capacity estimated at 130 million gal/yr (readily expansible to 150 million gal.). Phillips recovers cyclohexane directly from refinery naphthas, the others produce it by hydrogenation of benzene.

A premium is placed on high purity in cyclohexane which is to be consumed by air oxidation. Cier[15] points out that concentrates of at least 98 wt-% and perhaps as high as 99+ wt-% will be required to meet customer approval. Furman[1] calls for cyclohexane purity above 99%. This quality is obtained most simply by benzene hydrogenation.

While cyclohexane is present in refinery naptha streams these mixtures are so complex that plain fractionation will not yield a cyclohexane concentrate containing more than 80-85% cyclohexane. However, the material can be recovered in adequate purity by a combination extractive distillation-fractionation process, using anhydrous phenol as the extractive distillation agent. For such an approach, Cier[15] reports production of cyclohexane in a purity of 99.2 %. Using as feedstock, a concenerate containing 35.8% cyclohexane, product of satisfactorily high purity was recovered in 84% yield.

Methyl cyclopentane is available in petroleum fractions in substantially larger concentration than is cyclohexane. Isomerization of methyl cyclopentane to cyclohexane thus offers a potentially attractive means for broadening the raw materials base for the production of cyclohexanone. Actually, this approach is best by considerable technical difficulties, and it is not today practiced commercially in cyclohexane production.

Main difficulty is the unfavorable equilibrium at the relatively high temperatures which are needed for the isomerization reaction.[9] Thus, while ring expansion of ethyl cyclopentane over a WS_2—NiS—Al_2O_3 catalyst proceeds readily at temperatures between 500 and 580C, attempts to isomerize methyl cyclopentane under these conditions led to only trace formation of cyclohexane[9], i.e. even less than the 6% conversion which is calculated.

Better results were obtained[14] over nickel-silica-alumina catalyst in experiments for the isomerization of methyl cyclpentane at 280-370C. In this temperature range, the equilibrium composition of methyl cyclopentane, cyclohexane mixtures contains 22 to 10% cyclohexane. Actual cyclohexane formation ranged from 14.5 to 10.2%.

Technology of Cyclohexane Oxidation

Air oxidation of cyclohexane may be carried out, in the liquid phase, either non-catalytically or catalytically in the presence of soluble cobalt salts. The oxidation involves a free radical chain mechanism in which cyclohexane hydroperoxide is formed as intermediate product. This compound cannot, however, be isolated — its rate of formation becomes significant only in a temperature range (above 150C) where it is almost immediately decomposed. Accordingly, a controlled decomposition of the hydroperoxide, which could conceivably lead to very high cyclohexanol yield, is not possible. Instead, practical execution of the process will necessarily lead to the simultaneous formation of other oxidation products.

Thus, cyclohexyl hydroperoxide breaks down further into cyclohexanol and, via dehydration, into cyclohexanone. Further reaction of these primary products leads to adipic acid and its esters, caprolactone, ω—oxycaproic acid, adipic acid esters, as well as to various polymers and some of the lower mono—and dicarboxylic acids and their esters with cyclohexanol, to carbon monoxide, and to carbon dioxide.

Principle cause of product loss is the further oxidative breakdown of cyclohexanone. According to Smeykal[14], two main approaches may be taken for minimizing such breakdown reactions.

(1) Operation at short contact time. According to this author optimum residence time in non-catalytic oxidation is between 6 and 10 minutes.

(2) Operation at low conversion, by using a low air to cyclohexane ratio. Thus, the relation between per-pass conversion and yield of cyclohexanone/cyclohexanol is as follows:

Per Pass Conversion	Yield of Cyclohexanone plus Cyclohexanol
5	68
10	61
13	52

Obviously, it is not economically feasible to operate at too low a conversion because of the ineffective utilization of reactor space and the large amount of cyclohexane which must be recovered by fractionation and recycled.

Optimum economic level of conversion depends on numerous cost factors determined locally. It is found in the range 7-12% per pass, and is usually close to 10% in catalytic conversion, 8% in non-catalytic operation.

Non-Catalytic Oxidation

Fig. 1 shows a flow scheme employed in the air oxidation of cyclohexane (in this case, a non-catalytic process).[4]

Air and cyclohexane are introduced into the oxidation reactor. The reaction product is separated into aqueous and organic phases. The cyclohexane layer is washed with dilute caustic and is then taken to a train of fractionation columns. In the first of these, cyclohexane is taken off overhead and is recirculated to the oxidation stage. The column bottoms are taken to a secondary fractionation tower in which cyclohexanone is removed overhead, and cyclohexanol is withdrawn as a side stream which is fed directly to the alcohol dehydrogenation. The product of this dehydrogenation is returned to the cyclohexanone,—ol column for recovery of its contained cyclohexanone. The aqueous layer obtained from the oxidation reaction is subjected to azeotropic distillation for overhead recovery of a crude cyclohexanone, —ol product which is combined with the crude organic reactor make stream. The bottoms formed in the azeotropic distillation are freed of water and are then subjected to nitric oxidation for conversion to adipic gases.

For the non-catalytic oxidation of cyclohexane, work at Leuna[4] indicates optimum performance at 35 atmospheres and 180C. Cyclohexane and air are introduced countercurrently into the continuous oxidation reactor. Contact time is about ten minutes. Air: hydrocarbon ratio controlled to a per-pass conversion 7-8%. A small amount of water (about 5% based on cyclohexane

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feed) is introduced continuously into the reactor. Its purpose is to wash out acid oxidation products, such as adipic acid, which are only slightly soluble in cyclohexane. At the same time addition of water minimizes the danger of a runaway reaction. It should be noted that, by contrast, the addition of water in *catalytic* oxidation is deleterious.

Adequate means must be provided in the reactor for removal of the heat of reaction which amounts to about 1200 to 1300 Btu/lb converted cyclohexane.

The reactor's tail gas contains mainly nitrogen together with about 1-2% CO_2, 1-2% carbon monoxide, plus some cyclohexane and lower hydrocarbons. Its oxygen content is practically nil.

The organic layer is washed with 3% sodium hydroxide solution at 60C in order to neutralize contained carboxylic acids and saponify esters and lactones, thereby converting them to water-soluble sodium salts.

The bottoms product leaving the cyclohexane column contains 35% cyclohexanone, 64% cyclohexanol, and about 1% cyclohexanone. This column is operated at atmospheric pressure with a reflux ratio of 1:1. Residual cyclohexane, water, and other light boilers are taken off in an intermediate column operated at atmospheric pressure. The main stream of the cyclohexanol-cyclohexanone product is then fractionated in vacuo. Cyclohexanol is dehydrogenated over zinc-iron or zinc sulfide catalyst. Cyclohexanone obtained in the process has a purity of 95.8%.

In the course of the process, two aqueous layers are formed. One of these is obtained in the oxidation reactor itself, while the other is an alkaline solution formed in the course of the washing step. The former contains about 75-80% water, 3-4% cyclohexanol and cyclohexanone, and 20% acid reaction product. Azeotropic distillation will remove cyclohexanone and cyclohexanol quantitatively, together with about 10% of the water present in the stream. Bottoms product from the azeotropic column is freed of its water content by passage through a falling-film evaporator operated at 100 mm Hg. The oil recovered in the evaporation step is subjected to nitric acid oxidation for conversion to adipic acid. The product obtained by this oxidation contains 60% adipic acid, 25% glutaric acid, 15% succinic acid and 10% oxalic acid.

The alkaline solution leaving the washing tower contains 3% sodium salts of organic carboxylic acids and about 1-2% dissolved cyclohexanone and cyclohexanol. The latter two components are removed from the solution by steam distillation. No attempt is made to recover the sodium salts of organic acids.

Catalytic Oxidation

The catalytic air oxidation of cyclohexane is also carried out in the liquid phase. In every known commercial process, the catalyst is an oil-soluble salt of cobalt.

Fairly early in the work on the catalytic air oxidation of cyclohexane, it was recognized that the accumulation of benzene and other hydrocarbons in recycled cyclohexane as well as the buildup of water of formation has a significantly depressive effect on the reaction rate and efficiency. To overcome this problem, Hamblet and Chance[11] developed a process in which water as well as hydrocarbon impurities are removed azeotropically during the reaction. This approach makes it feasible to employ as feedstock a petroleum-derived cyclohexane which contains not only some sulfur but also benzene in a concentration of several tenths of a percent plus close-boiling aliphatic and naphthenic hydrocarbons.

The process is carried out continuously. Several[3] stirred autoclaves, set in series, serve as reaction vessels. Each autoclave is equipped with an overhead reflux condenser, provided with means for water withdrawal. Air enters the bottom of each autoclave.

Effluent from the final reaction stage is steam-distilled for the overhead removal of hydrocarbons. The bottoms are the desired crude oxidation product. The overhead is water-washed and then subjected to azeotropic distillation for overhead removal of benzene and other hydrocarbon contaminants and bottoms recovery of cyclohexane to be recycled to the first oxidizer stage.

Steeman, et al.[2] have investigated the catalytic air oxidation of cyclohexane, with the following main conclusions:

(1) The reaction is subject to the lengthy incubation period which is generally observed in autoxidation processes. This period can be minimized by the presence of a peroxide or of cyclohexanone in the reactor, which can be attained by back-mixing.

Inherently, a batch oxidation permits higher yield of useful product than is achieved in continuous operation. Thus, at 10% conversion, Steeman obtained 70% efficiency in the batch process vs. only 63% in truly continuous operation.

The higher efficiency of the batch process may be approached in continuous oxidation by carrying out the conversion in a series of autoclaves. Steeman calculates that three autoclaves arranged in series constitute the economical optimum for the oxidation of cyclohexane.

The effect of operating variables is reported[2] as follows:

(1) *Temperature*. Reaction rate below 140C is insignificant. Optimum efficiency is attained in the range 155-160C.

(2) *Pressure*. Should be controlled to the boiling point of cyclohexane at the operating temperature. In the range 155-160C, this means that the autoclaves are operated at 8-9 atmospheres. This approach permits ready removal of the heat of reaction by evaporation of cyclohexane which is then condensed overhead and recycled, either to each of the autoclaves or only to the first converter in the series.

(3) *Feed Rates* may be varied widely. Steeman's investigation covered cyclohexane feed rates ranging from 1.3 to 3.5 vols/vol/hr, while air rate was varied from 200 to 500 vols/vol/hr.

(4) *Method of Mixing*. Air and cyclohexane has significant influence on efficiency and operating rate. For stable operation, the liquid phase should be well stirred.

Steeman's comparison of turbo-stirrers, propellers, and Hofer stirrers showed best performance for the last-named. The preferred means for introducing air into the liquid is through distributor plates whereby it was noted that reduction in the size of air bubbles resulted in a decrease in efficiency. This effect is ascribed to the fact that the reaction rate is very high, and the mass transfer coefficient from the bubble to the liquid is controlling. It has been determined that this mass transfer coefficient for large bubbles is very much higher than for small bubbles.

Essentially complete conversion of oxygen may be taken. At a given operating temperature, pressure, and catalyst concentration, the air:cyclohexane ratio will therefore determine the degree of conversion and thus the operating efficiency. As would be

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expected, the efficiency drops with increasing air:cyclohexane ratio, though the relation is not entirely linear because the undesired by-products consume more oxygen per mole of cyclohexane than do cyclohexanol and -one.

(5) Increasing *residence time* at otherwise comparable conditions appears to have some favorable effect on the efficiency of the reaction. This phenomenon is not fully understood since the degree of conversion is controlled by the available oxygen.

As we have noted above, cyclohexane removed from the autoclave by evaporation for cooling effect may be recycled either to the first autoclave alone or it may be returned directly to each of the individual reactors. Indications are that the method by which such recycle is effected does not influence performance significantly.

(6) *Catalyst concentration* was controlled by Steeman[2] to the level at which no peroxides were observed in the reactor effluent. Additional concentration was found to be without value. Steeman attains the desired effect by using between 0.5-2.5 ppm cobalt octoate.

Another approach to the catalytic air oxidation of cyclohexane was taken by Furman et al.[1] Typical operating conditions were: 18-24 atmospheres, 130-140C, molar ratio of cyclohexane to oxygen (in air) 4.75:1, 40 ppm catalyst (cobalt stearate) on cyclohexane.

At these conditions, cyclohexane conversion per pass was 12%. The product was formed in two layers (organic and water). Combined content of useful products is reported as follows:

Cyclohexanone — 3.5%, cyclohexanol — 3.9% (of which 2.8% is in free form and 1.1% is present in the form of esters), organic acids—3.2%. The latter were found to consist of 80% adipic acid and 20% other dicarboxylic acids, namely oxalic, succinic and glutaric acids. Combined yield of cyclohexanone, -ol, and adipic acid is reported at 80% on converted cyclohexane. Including all dicarboxylic acids, total useful products were formed in a yield of 87%.

When water was contained in the cyclohexane feedstock, per pass conversion droped to 11.3%. At the same time the ratio of cyclohexanone to -ol was sharply changed in favor of the alcohol and, at the same time, there was a significant increase in the formation of esters. Even more serious was the effect of benzene on the conversion. Even a low benzene concentration in the feedstock will cause significant build-up in the cyclohexane recycle, and will eventually reduce per pass conversion to 8-9%.

Reduction in air:hydrocarbon ratio was accompanied by a corresponding decrease in the oxygen content of the tail gas, while conversion and yield of useful products is affected in an only minor way as long as some excess oxygen (2-3% in the off gas) is available. Such decrease in air rate results in lower compression costs. It is also desirable because it reduces the burden imposed on the system for cyclohexane recovery from the spent gas.

Product Suitability as Intermediate

The crude product of cyclohexane oxidation is a complex mixture containing, above all, unconverted cyclohexane plus cyclohexanol and cyclohexanone. Also present are adipic acid and lower carboxylic acids and their esters with cyclohexanol, some aldehydes, acetals, polymers, lactones, etc.

It is, of course, possible to purify cyclohexanol and cyclohexanone and to use these components as starting material for the further conversion to adipic acid. However, it is more profitable to use the crude product of cyclohexane oxidation. This saves intermediate refining steps. Furthermore, some adipic acid is already present in the crude cyclohexanol, -one mixture and various by-products are also present which yield adipic acid upon nitric acid oxidation.

According to Lindsay[20] typical adipic acid yield of cyclohexane is 52% if the intermedite products are refined. On the other hand, an overall yield of 63% can be obtained by running the crude primary (air) oxidation products directly to the adipic acid manufacturing stage.

A similar conclusion is reached by Lubyanitski[5] who points out that the nitric acid oxidation of cyclohexanone proceeds less readily than the corresponding conversion of cyclohexanol. Mixtures of the pure components gave an adipic acid yield of 75% from pure cyclohexanone, 50% from a 20% cyclohexanone—80% cyclohexanol mixture. From here, yield rises to 80-83% in the conversion of mixtures containing more than 80% cyclohexanol. More significantly, the nitric acid oxidation of a mixture containing cyclohexanol and cyclohexanone in the ratio two to one, corresponding approximately to the product of cyclohexane oxidation, gave an adipic acid yield of nearly 80%.

In the production of cyclohexanone for caprolactam synthesis, it is necessary to isolate cyclohexanol and cyclohexanone from the crude product. Here, the recovery system following the oxidation stage consists of the following key elements:

(1) Separation of the organic and aqueous layers followed by neutralization of the organic phase.

(2) Separation and recovery of unreacted cyclohexane.

(3) Separation of crude cyclohexanone.

(4) Purification of cyclohexanone by fractionation of the crude reaction product.

(5) Recovery and purification of cyclohexanol.

The separation of the two phases formed in the course of the oxidation reaction is preferably carried out at elevated temperature (70-100C). The reason is that the distribution coefficient of adipic acid between water and cyclohexane increases significantly with rising temperature (from 31.7 at 20 to 90.0 at 70), while the coefficient for cyclohexanone and -ol decreases slightly. As a result, phase separation at higher temperatures reduces the amount of caustic needed for neutralizing the organic phase prior to fractionation.

Separation and purification of useful products is effected by a sequence of azeotropic and straight fractionation steps, along the lines indicated in the above discussion of a non-catalytic oxidation process. Further useful information on fractionation characteristics of the product of cyclohexane oxidation in various types of column has recently been reported by Olevskyi.[3]

Dehydrogenation of Cyclohexanol

In the production of cyclohexanone for caprolactam synthesis, a key step is the dehydrogenation of cyclohexanol. For this conversion, numerous catalysts have been proposed, among them copper-aluminum-nickel (58:48:2), Ni-Cu-Cv_2O_3 platinum, Raney nickel, etc. Commercial interest appears to be limited to zinc-based catalysts, among them zinc sulfide and zinc-iron.

Freidlin[7] has investigated the dehydrogenation of cyclohexanol over a zinc-based catalyst. The conversion was carried out in the vapor phase at 380-420C. with a volumetric space velocity of 1 hour.[1]

The product of this conversion was found to contain about 80-85% cyclohexanone and 10-15% unreacted cyclohexanol. Also present were 0.3-0.5% cyclohexene, 0.1-0.2% water, 0.1-0.15% phenol, 0.02-0.03% cyclohexyl esters, and 0.5-1% cyclohexylidene cyclohexanone-2. Thus, the formation of by-products is only 1-1.5% of the converted cyclohexanone. This material is recovered as bottoms in the cyclohexanol fractionation column. Its quantity is small enough to permit running it to waste. However, it may be converted to cyclohexanone in 40 wt-% yield by treatment with 1% aqueous caustic at 250-270C. END

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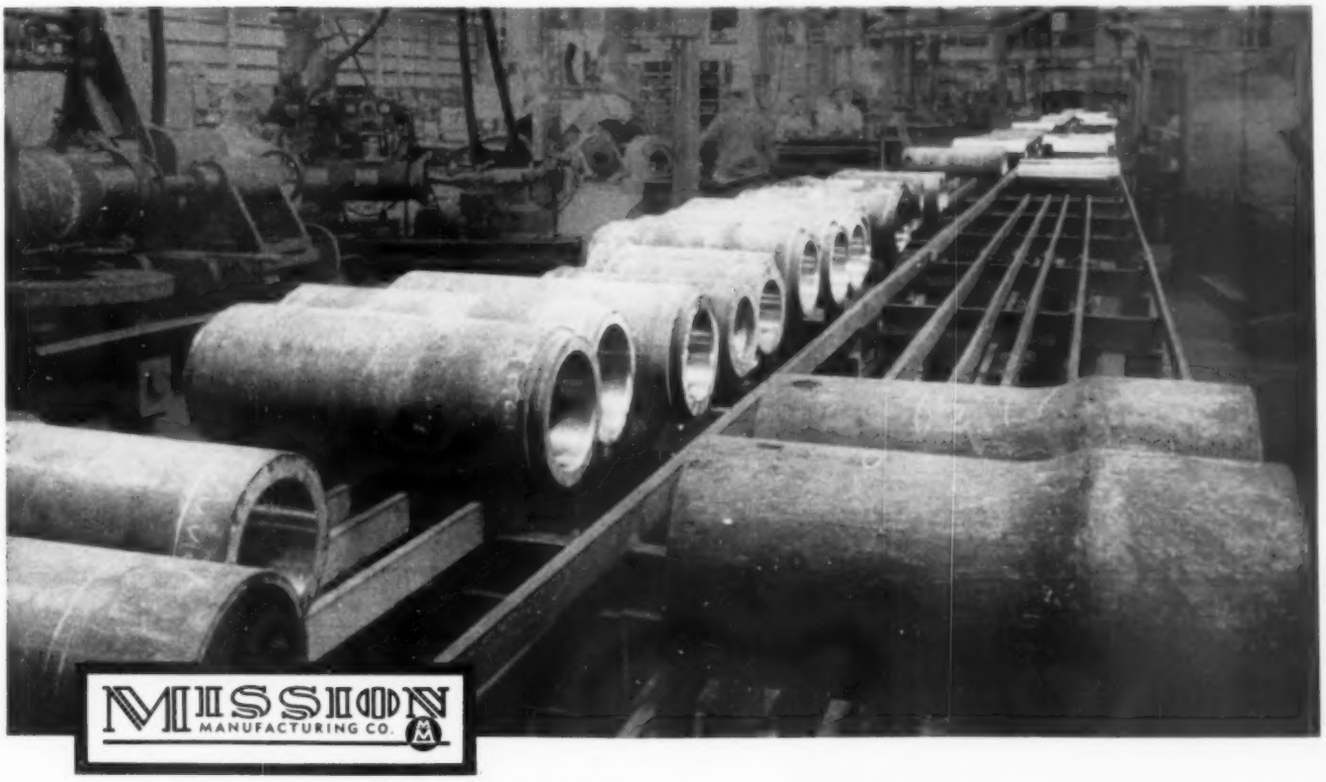

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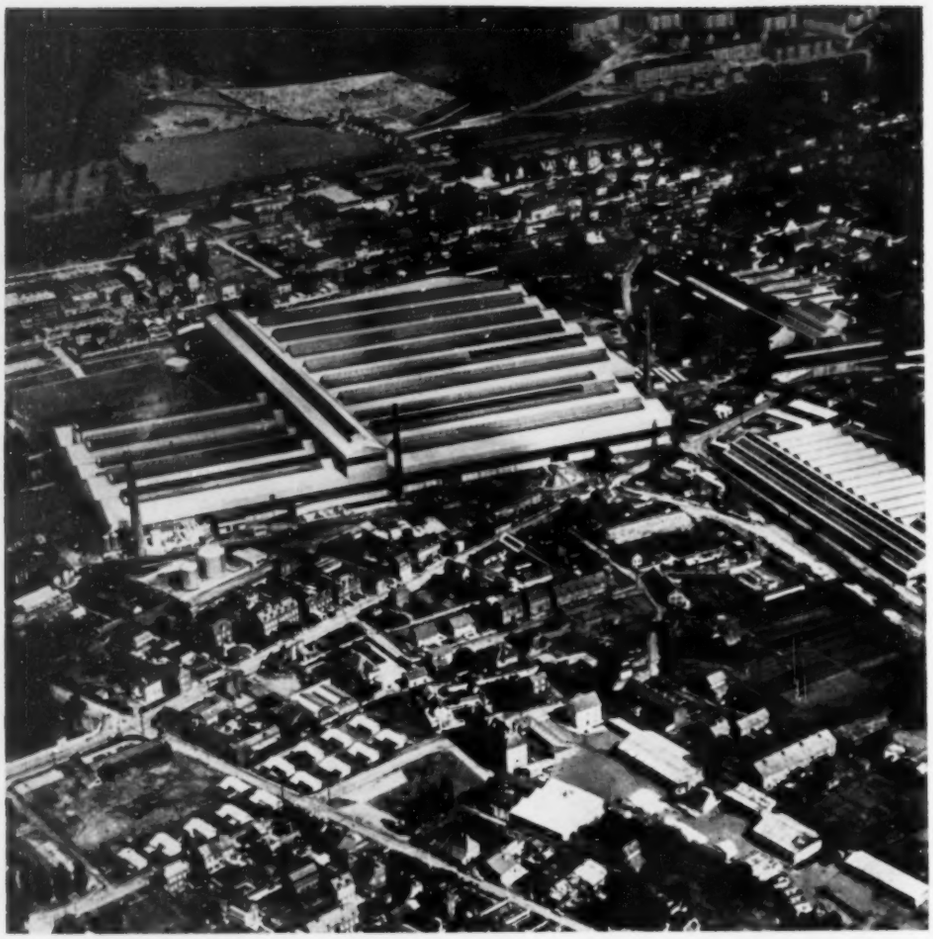
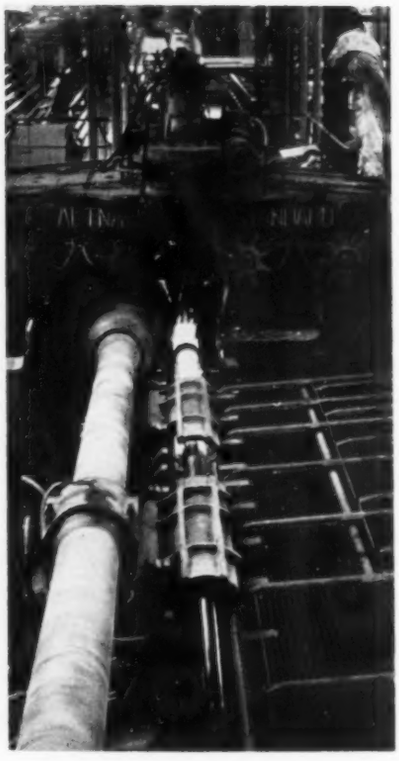


A new factory for seamless



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Notable historically as the site where St. Joan of Arc, the nineteen-year-old Maid who led 15th-Century French Armies to victory over the English, met martydom on a blazing pyre in its marketplace, Rouen today is a bustling fresh-water port located sixty miles inland on the Seine River. Scores of cranes arch its piers, unloading cargoes from around the world, and in turn filling holds with the products of its own industry.

Being on the Seine north of Paris, Rouen is in easy reach of ocean traffic coming down the river from Le Havre, as well as the excellent road-and-rail network extending into the industrial North and Eastern regions of France. The city's excellent location was an important factor in its selection as the site of the new mill, another in the important steel-production complex managed by Sidelor.

The Sidelor group in turn is an important division of Pont-à-Mousson, a major world-wide holding Company in the iron and coal mining, sewage pipe systems, steel and steel pipe industries. In steel production, Pont-à-Mousson has an annual capacity of 5 million tons.

Pont-à-Mousson offers a full range of pipe-line products and pipe-laying services since in addition to its subsidiary plant at Déville it also directs the operations of the Belleville plant in eastern France. This latter plant is equipped for the production of large diameter welded steel pipe.

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installations Companies with a capital equipment investment of 10 million dollars. Another subsidiary, the Ludwigshafen plant in Germany manufactures oil-pumps.

All these plants are recently built and enabled PONT-A-MOUSSON to play a key-role in the development of the oil and gas deposits at Lacq and in the Sahara. Presently, the firm is heavily engaged in the construction of the sub-European pipeline which will connect the Mediterranean port of Marseilles with Karlsruhe in West-Germany.

Perhaps its outstanding characteristic from production capacity and quality control standpoint is the immense mill's adherence to proved U. S.—manufacturing techniques. In fact, the Deville-les-Rouen operation can be termed in concept a "sister" mill to the three recently-built modern units in the United States making similar products.

Five million dollars was spent for production equipment imported from the U. S., another 2.5 million for French equipment built under American license. The main element, an entirely automated plug-rolling-mill, was supplied and installed by Aetna-Standard. The huge rotary hearth furnace was constructed by Stein & Roubaix, a French company, under U. S. license. And following through further this practical example of French-American industrial cooperation, a large percentage of subsidiary equipment was also furnished by French manufacturers working with American licenses.

There is latitude for an extremely wide range of seamless tube and pipe production, designed to meet American and European specifications. Sizes from 1-1/3″ to 10¾″ diameters in all grades in available, and all modern facilities for straightening, cutting and hydrostatic testing of tubes and pipes up to 13,000 PSI. Auxiliary shops handle end-upsetting, heat treatment, quenching and tempering operations.

Noteworthy is the fact this factory production has received the American Petroleum Institute label and is under supervision and rigid control of Moody Engineering. To go further in meeting the high American requirements in the oil industry, the firm has concluded an agreement of technical assistance, for exchange of experience and information with National Supply Company.

From the outset all operations have been supervised by American consulting engineer, Mr. F. W. BREMMER of Pittsburgh

(Continued on next page)

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A New Factory

(Continued from preceding page)

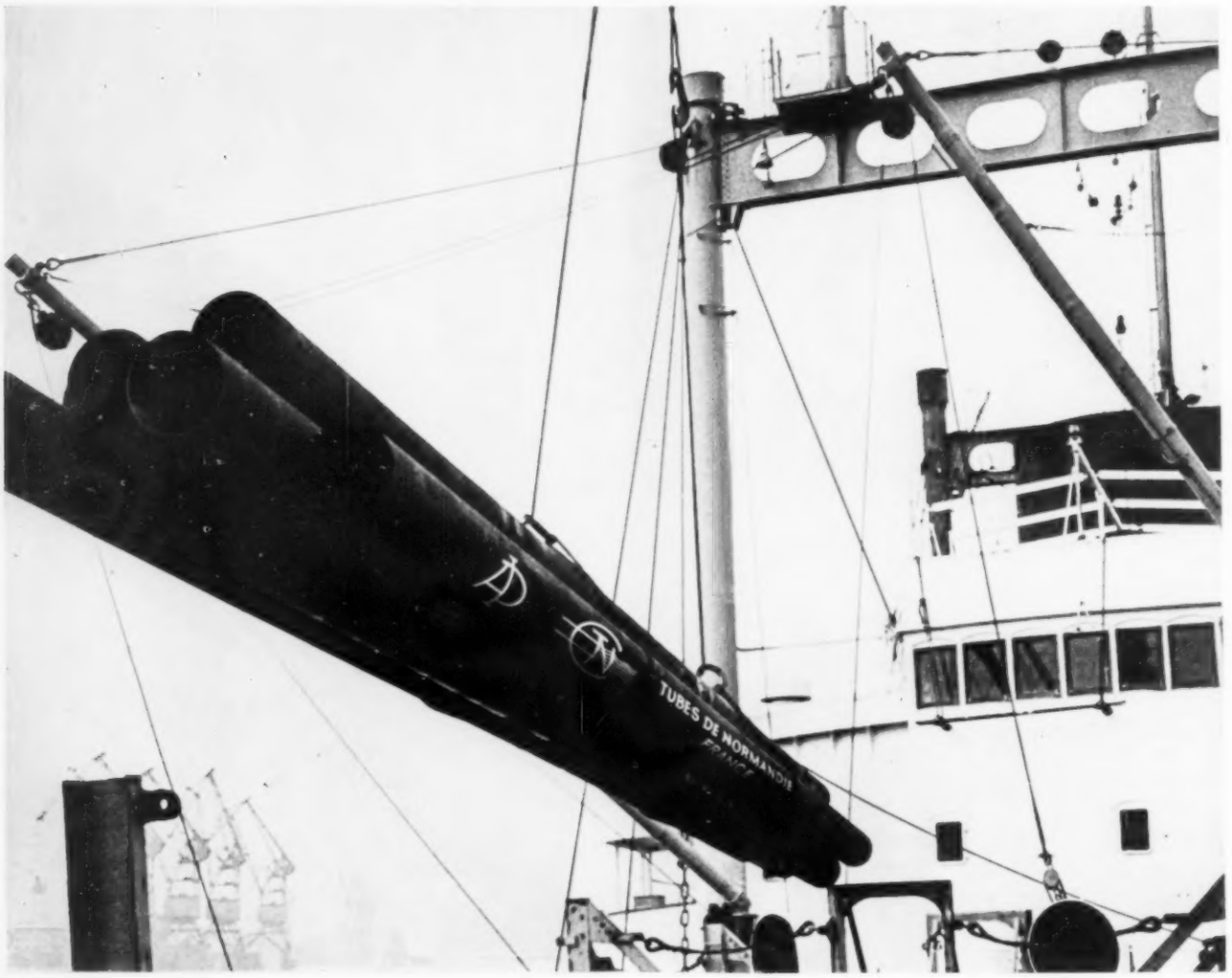
formerly with Nation Supply. In his opinion the mill's output is equal or better in quality to any other world source.

The sales staff looks to the future with confidence. The Common Market, the Sahara and Libya, and Africa, promise ready markets. The Middle East, South America and Canada hold further prospects. Already supplying many countries the world over, heavily engaged in oil field development, the Company has contracts with O.P.I. in Iran, with ENAP in Chile, with American producers in Peru, in Columbia and Canada. The firm intends to export 50% of its total production of seamless pipe and tubing and realizes a stiff competitive fight lies ahead.

The Deville-les-Rouen plant has sales representation through the Davum Export Company, a Pont-à-Mousson commercial subsidiary. With sales offices in principal cities around the world—especially in active oil areas—Davum can provide the technical sales service users require and augment in a practical way the mill's aim to provide the petroleum industry with a superior product as well as good technical sales service.

With a tube being produced every 30 seconds when in full operation, mill-capacity could reach 25,000 tons monthly. Presently however, output is steady at 10,000 to 13,000 tons/month. The reason is that demand for one particular size in a definite grade is not yet big enough for big lines of monoproduction. However, versatility is also an asset, at least in Europe, the Deville-les-Rouen plant will be able to supply to order any size up to 10¾ outside diameter in the best grades of steel including P 110, the highest grade in A.P.I. specification.

Recently, the Company supplied specific line pipe for experiment on the sub-mediterranean gas-line from the Sahara to Europe. Some small-inch lines, that of El-Gassi in the Sahara as example have also been built with seamless pipes from Deville-les-Rouen.



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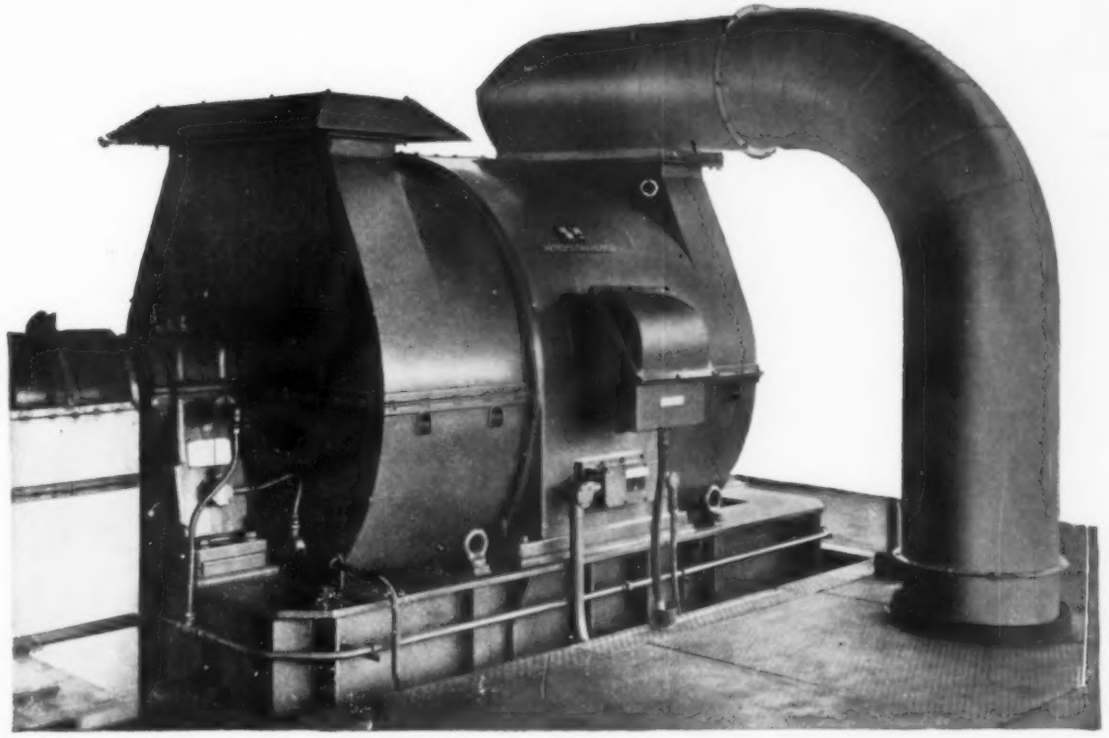
PARIS 24, rue de Prony (17e) — NEW YORK Pontex Pipe Corp. 116, John St., Suite 1317, New York 38, N. Y.—SAO PAULO Rua Marconi 131 (7th andar)—MEXICO DF Apartado 1014 Monterrey 29—BUENOS AIRES Calle Peru 263, 7e Piso—BEYROUTH P.O.B. 3359—BANGKOK P.O.B. 280.

Advertisement

3000 hp-3000 volts,

Direct-on-line started motors at Fawley



This 3000 hp., 1485 r.p.m., 3kV motor is the largest direct-on power-line started machine to be installed in a British oil refinery; it is a Type AMS, pipe-ventilated, squirrel-cage induction motor and drives the main air compressor on the Hydroformer unit at the Esso Oil Refinery, Fawley. A similar rated machine, but force-ventilated because of the hazard, drives a hydrogen compressor on the same unit.

AEI motors are in use in oil refineries throughout the world, complete ranges of such motors have been designed by AEI Engineers to meet the specialized requirements of the oil industry. These motors embody the experience gained over many years and incorporate features which are essential to the oil industry.

AEI

Associated Electrical Industries Limited
Motor and Control Gear Division
RUGBY AND MANCHESTER, ENGLAND

A5539

OIL COMPANY STAFF CHANGES

Perrin Fay

F. C. Boucke

J. R. Donnell

M. V. Carson

FRED C. BOUCKE has been appointed assistant to the chairman of Standard Oil Co. of California. He has been serving in London as president of Iran California Oil Co., subsidiary which manages Standard's 7% interest in the Iranian Oil Consortium. Boucke will be succeeded as Irancal's president by **E. PERRIN FAY,** previously assistant manager of Standard's eastern hemisphere operations staff.

ROBERT O. JENNINGS has been appointed a vice president of Signal Oil and Gas Co.

GEORGE S. ECCLES has been named a director of Canadian Husky Oil Ltd. and its subsidiary, Husky Oil Co. of Cody, Wyoming. Eccles is president of First Security Co. and First Security Investment Co., both of Salt Lake City.

Ohio Oil Co. has made legal, accounting and treasury appointments to its newly-created international organization. **WILLIAM K. TELL,** general attorney, was given responsibility for the legal aspects of the international operations. **KENNETH M. BURNS,** assistant controller, was named to direct the international group's accounting work and assistant treasurer **ELMER A. GRAHAM** will be responsible for financial activities of the international operations.

COOKE BAUSMAN, JR. has been appointed manager of marketing, petrochemicals department, Gulf Oil Corp. He will direct Gulf's program for marketing of petrochemicals both in the USA and abroad. His headquarters will continue in New York.

JOHN G. McLEAN, financial vice president of Continental Oil Co., has been elected a director of Continental. He will continue to make his headquarters in New York City. McLean has also been made vice president for international and financial activities, in which capacity he will assist A. W. Tarkington, senior vice president.

JAMES K. WARNE has been appointed general manager of the Gulf Oil Corp., Philadelphia refinery, succeeding **THOMAS A. DIETZ,** who has been transferred to the Pittsburgh general office on a temporary assignment.

EDWARD T. HERNDON, a senior partner of Eastman, Dillon, Union Securities & Co., has been elected a director of Mission Development Co. Mission Development controls Tidewater Oil Co. and is, in turn, controlled by Getty Oil Co.

DR. ROMULO QUINTERO, Venezuelan chemical engineer, has been appointed manager of manufacturing and a director of Mobil Oil Co. de Venezuela. Dr. Quintero, 40, has been with Mobile de Venezuela for six years. For the past seven months he has been manager of Mobil's 50,080 b/d refinery at El Palito.

Dr. R. Quintero

M. L. Haider

JOHN R. DONNELL, vice president of supply and transportation and member of the board of directors since 1954, has been named vice president in charge of all The Ohio Oil Co.'s international activities. He will assume broad new responsibilities for coordination of the company's exploration, production, transportation, refining and marketing activities over an area which already includes ten countries outside the USA.

Donnell will head a specialized organization of internationally-oriented personnel devoting full time to the rapidly-expanding international phase of the company's business. Headquarters for the international orginaztion will be at the Ohio Oil general office in Findlay.

Succeeding Donnell as vice president of supply and transportation will be **JACK H. RICE,** since 1960 president of Marathon Pipe Line Co., a wholly-owned Ohio Oil subisidiary.

J. RICHARD SHANER and **D. D. GRANDELIS,** two former members of the editorial staff of the now defunct *Peetroleum Week*, have organized a new public relations firm specializing in oil, natural gas, and petrochemicals. Shaner was previously chief press and information officer for the American Petroleum Institute for many years. The new firm is located at 500 Fifth Avenue, New York 36, N. Y.

HALLAN N. MARSH, a California petroleum consultant, received one of the top awards of the Society of Petroleum Engineers—the John Franklin Carll Award—at the 1961 Fall meeting of the Society in Dallas in October. The purpose of the Carll Award is to "recognize distinguished achievement in or contributions to petroleum engineering." Marsh retired in 1960 as manager, production and equipment section, Mobil Oil Co. in Los Angeles. He has a national reputation as an authority on oil well pumping, as an author of technical papers, and as the inventor of oilwell measuring devices. The "Marsh funnel" is named for him.

PAUL L. FAHRNEY and **ELMER R. PETERSON** have been elected to the Board of Standard Oil Co. of California. Fahrney has most recently been vice president for national marketing policies. Peterson has been vice president in charge of financial affairs.

E. L. STAUFFACHER, vice president of Cities Service Co., has been named coordinator of light end products for the Cities Service system. He will be assisted by **G. C. RICHARDSON,** with headquarters in Bartlesville, Okla.

J. PAUL GETTY, head of Getty Oil Co., has accepted the position of consulting editor in business and finance of Playboy Magazine. Getty, whose properties include world-wide oil holdings, a fleet of super tankers, an aircraft company, office buildings, and hotels, has been writing a series of exclusive articles for the magazine. His latest, entitled, "How I Made My First Billion," was released in the October issue.

JOHN C. QUILTY has been elected vice president of personnel and industrial relations for Shell Oil Co. to succeed **E. H. WALKER,** who retires December 1.

MICHAEL L. HAIDER has been elected an executive vice president and a member of the executive committee of Standard Oil Co. (New Jersey). Haider, who was a vice president and director of the company, continues on the Jersey board with responsibility as a contact director for Jersey affiliates and activities in Latin America.

MATTHEW V. CARSON, JR., from April 1, 1958 to April 1, 1961 director of the Office of Oil & Gas, Department of the Interior, has been elected a vice president of Sinclair Refining Co. Carson, who also was the first administrator of the mandatory oil import program, is being assigned to the Washington office of Sinclair Refining Co. as representative of the company replacing **ORVILLE D. JUDD,** vice president, who has represented Sinclair in Washington since May 18, 1951, and who will remain in Washington on special assignments for the company.

ARNOLD STEBINGER has been appointed international government relations advisor in the new government relations department of Socony Mobil Oil Co. The department was established Oct. 1, with Christian A. Herter Jr., as general manager. Since March 1959, as regional vice president (Far East) of Mobil International, Stebinger has been concerned with Mobil's interest in Standard-Vacuum Oil Company.

MILLBURN S. WEIR was appointed superintendent of operations; **W. D. BASKIN** was appointed superintendent-maintenance and engineering; and **MURL LUCAS** was appointed administrative supervisor of the Oxo Chemicals Co. plant now under construction at Haverhill, Ohio.

HAROLD F. WINHAM, Shell Oil Co., is the recipient of the Certificate of Service of the Society of Petroleum Engineers of AIME (American Institute of Mining, Metallurgical and Petroleum Engineers). He received the award at the membership Luncheon on Oct. 10, during the 1961 SPE Fall Meeting in Dallas. Making the award was SPE President Earl M. Kipp, Standard Oil Co. of California.

WILLIAM F. BROWN, manager of petrochemical planning, has been appointed to Continental Oil Co.'s international department staff, with headquarters in New York.

W. T. MADDOCK, a senior refining engineer with The Ohio Oil Co., has been named assistant to **B. B. MILLER,** who was recently appointed Ohio Oil's refining representative in Europe. Maddock will assist Miller in all responsibilities relative to Ohio Oil's refining interests in Spain and other European countries. In the next few months, Maddock will work both here and abroad and he will make his headquarters in Europe after Jan. 1, 1962.

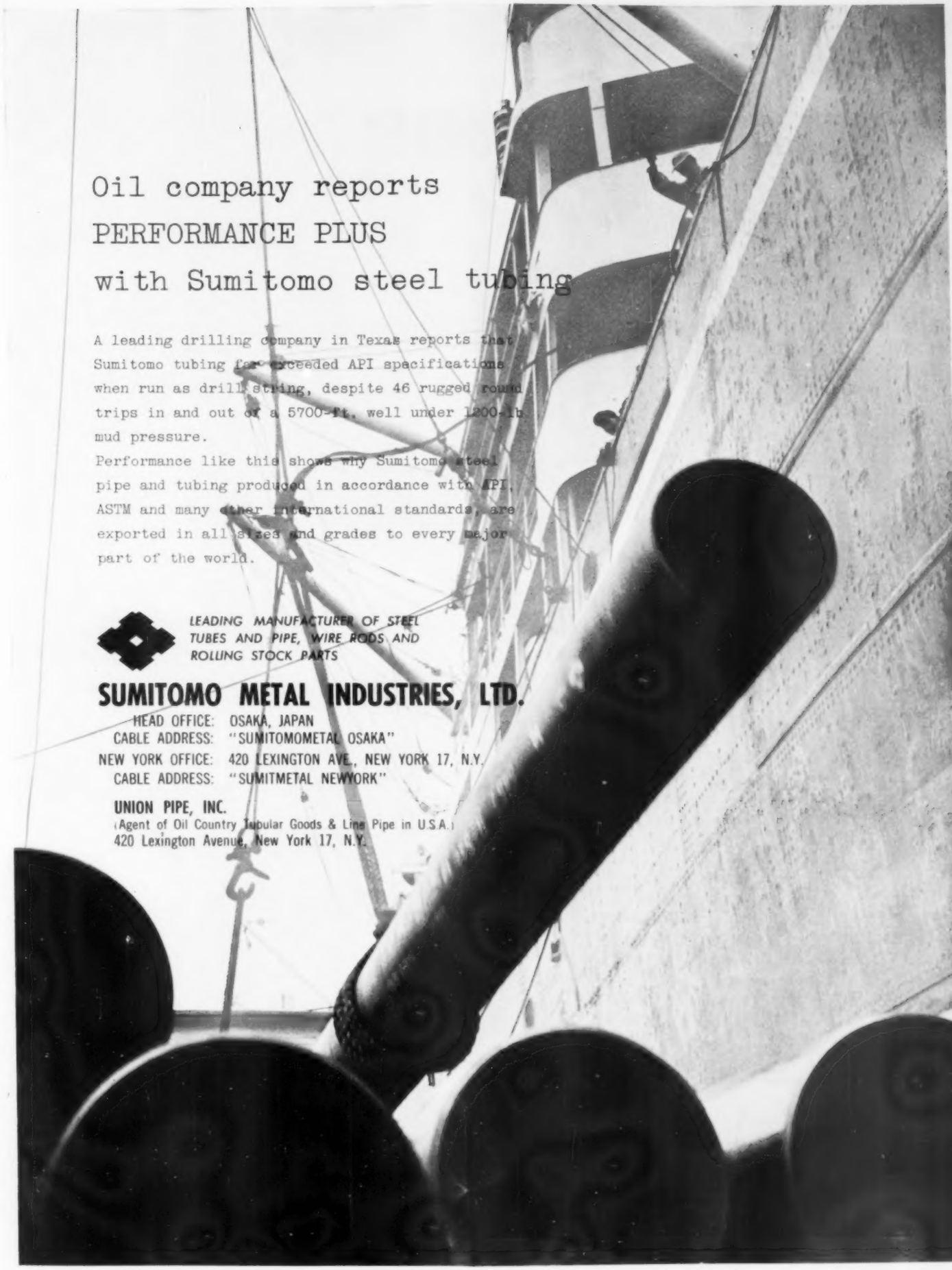
OTIS F. COZIER

Otis F. Cozier, 64, mid-continent advertising representative for WORLD PETROLEUM died of a heart attack at Houston on Oct. 7. Mr. Cozier had been engaged in oil industry advertising sales work for the past 39 years. He joined the Platt oil publications in Cleveland in 1922 and was transferred to Tulsa five years later. He was appointed manager of the Tulsa offices of WORLD PETROLEUM in 1942.

In recent years Mr. Cozier has been assisted by his son, Jack F. Cozier, who now will continue as the WORLD PETROLEUM representative in the southwest.

Mr. Cozier is survived by his widow, his son and two sisters. Burial was at his boyhood home in Sidney, Ohio.

(Continued)



Oil company reports PERFORMANCE PLUS with Sumitomo steel tubing

A leading drilling company in Texas reports that Sumitomo tubing far exceeded API specifications when run as drill string, despite 46 rugged round trips in and out of a 5700-ft. well under 1200-lb mud pressure.

Performance like this shows why Sumitomo steel pipe and tubing produced in accordance with API, ASTM and many other international standards, are exported in all sizes and grades to every major part of the world.

LEADING MANUFACTURER OF STEEL TUBES AND PIPE, WIRE RODS AND ROLLING STOCK PARTS

SUMITOMO METAL INDUSTRIES, LTD.

HEAD OFFICE: OSAKA, JAPAN
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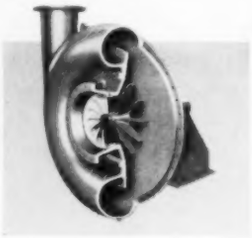
CABLE ADDRESS: "SUMITMETAL NEWYORK"

UNION PIPE, INC.
(Agent of Oil Country Tubular Goods & Line Pipe in U.S.A.)
420 Lexington Avenue, New York 17, N.Y.

ELLIOTT COMPRESSORS

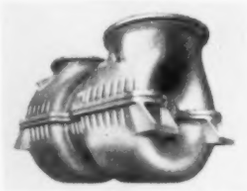
Today's most complete line of centrifugal and axial machines from 500 cfm to 600,000 cfm

48 FRAME SIZES WITH MATCHING DRIVERS. Elliott offers an unexcelled range of choice of established machines. In addition, there is the extra advantage of matching Elliott turbine or motor drivers. Because both units are engineered and built by Elliott, you get unified responsibility and service.



SINGLE-STAGE COMPRESSORS. Elliott single-stage centrifugal compressors range in size from 700 to 100,000 cfm and above. They are readily adaptable to special service conditions, and to the handling of corrosive or dirty gases.

MULTI-STAGE CENTRIFUGAL COMPRESSORS. Elliott multi-stage compressors are made in a wide variety of sizes and styles to serve the most difficult applications. They are available with inlet capacities up to approximately 150,000 cfm.



AXIAL FLOW COMPRESSORS. Multi-stage compressors of the axial flow type are designed and engineered specifically to handle air or gas mixtures in large volumes. Frame sizes are rated up to approximately 600,000 cfm when operating on air.

Other fine products of the Elliott Company include induction motors, synchronous motors, Crocker-Wheeler integral HP motors, motor generators, turbine-generators, ejectors, strainers and condensers.

For information on any of these products, send coupon to Industrial Equipment Sales Dept., Carrier International Ltd., 385 Madison Avenue, New York 17, N.Y.; Carrier A.G., Zurich, Switzerland, or Carrier-Lix Klett S.A., Buenos Aires, Argentina.

Carrier

Please send complete information on _____ (products)
to the following address:

Name _____

Address _____

City _____ Country _____

ARTHUR G. MECK has been appointed manager of Tidewater Oil Co.'s eastern division pipeline department.

G. F. BASSLER has been promoted to manager of personnel relations for Continental Oil Co.'s international operations, with headquarters in New York. He will succeed **SAM W. LEONARD**, who has been named controller, assistant treasurer and secretary of Petroquimica Argentina, S.A. (PASA), Buenos Aires, an affiliate of Continental. PASA recently announced plans to build nine inter-related petrochemical plants in Argentina.

VINCENT N. HURD to manager of the newly-formed petrochemicals department of Gulf Eastern Co. in London. He has been director of technical development in the petrochemicals department in the headquarters office of Gulf Oil Corp. in Pittsburgh. In his new capacity he will be responsible for petrochemicals activities in Europe and other areas of the Eastern Hemisphere.

ROBERT G. REED III has been appointed Tidewater Oil Co. marketing manager, succeeding **DON T. WHALEN**, who has assumed new marketing management duties for Tidewater in the Pacific Northwest.

FRANK N. IKARD of Wichita Falls, Texas, had been named to the newly created position of executive vice president of the American Petroleum Institute. He has been a United States congressman from the 13th District of Texas since 1951.

BP's New Hydraulic Rig

To meet Abu Dhabi Marine Area's special needs for offshore well servicing, British Petroleum's drilling branch has developed, in association with Oil Well Engineering Co., a new remote powered and fully flameproof hydraulic drive to a National T.32.S drawworks. It is believed this will show important advantages over conventional equipment, especially by providing highly flexible power without the need of the normal mechanical chain drive and torque converter.

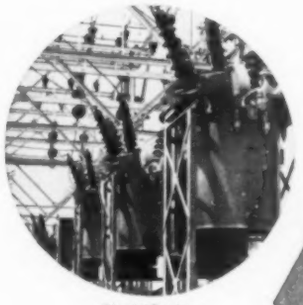
Power for the drawworks is a 400 hp Paxman diesel with 1,250 rpm maximum speed. This drives two Van Roll variable displacement hydraulic pumps, generally intended to be run at a constant 950 rpm speed, through reduction gear. At this speed these pumps have a maximum combined deplacement of some 360 gal/min of hydraulic oil. This will be transmitted by 4-in. steel piping from the work barge and thence by 3½-in. rotary hose to the drawworks, where the oil powers two fixed angle hydraulic motors, one mounted each end of the drawworks drive shaft.

By this division into two pumps and two motors, operations can be maintained in the event of failure of any single hydraulic unit. Varying the swash plate angle between 0° and 25° can alter the volume of the pumps and their pressure output to suit the load, with consequent variation of speed and torque output of the hydraulic motors at the drawworks.

A similar Paxman diesel with belt drive powers the mud pumps. The two are mounted side by side and may be compounded, giving flexibility of operation in case of engine shutdown as well as making available for pumping duties the balance of 800 hp minus only that needed for rotary table operation, while still leaving full control of rotary table speed via the swash plate angle.

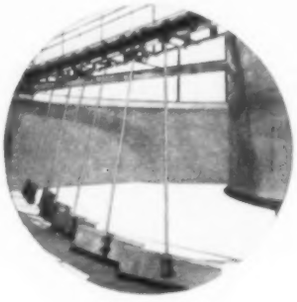
The equipment is at present in use in one of BP's new English oilfields in the Midlands.

Power Stations

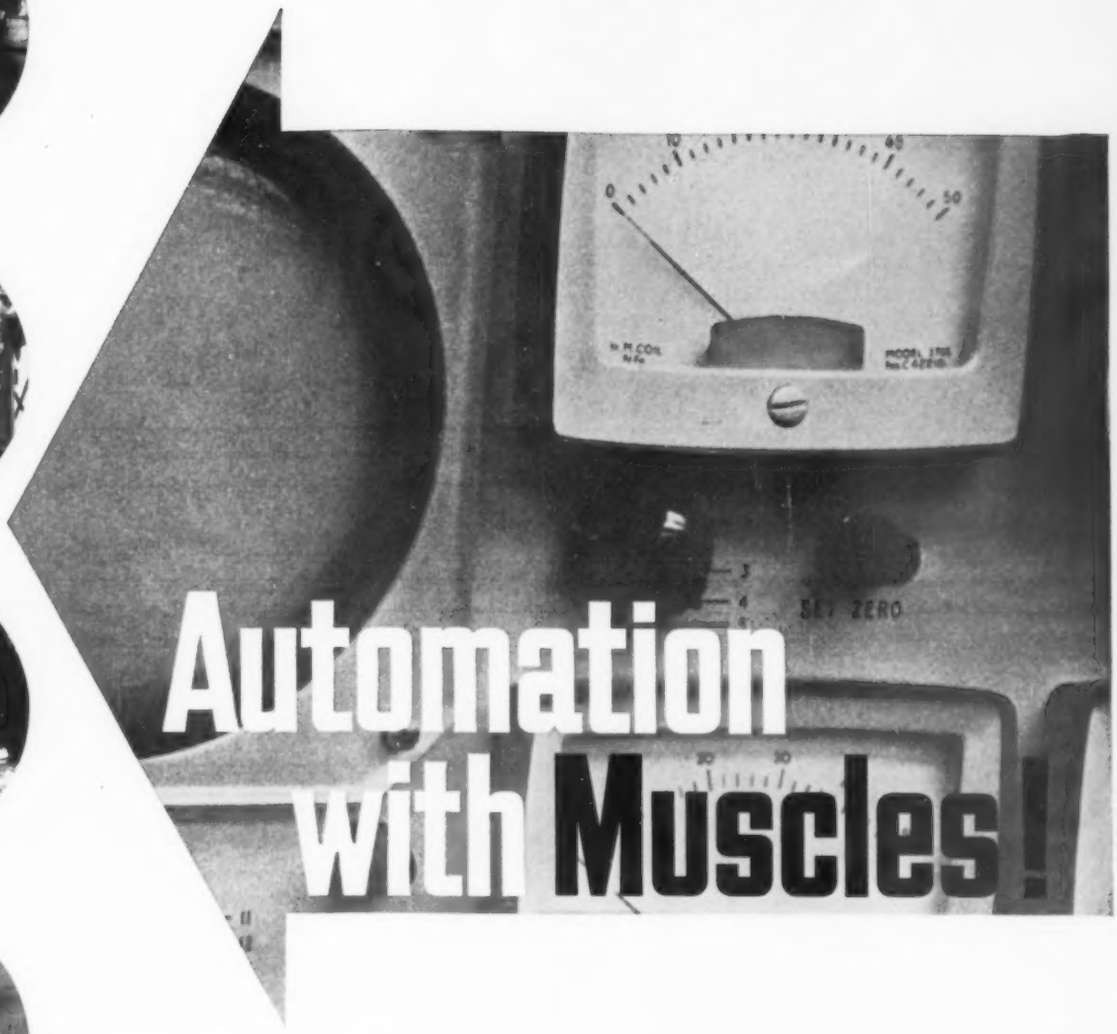


Electrification

Harbour Installations



Sewage Plant



Automation with Muscles!

A NEW CONCEPT IN POWER ENGINEERING

Now, for the first time, comprehensive automated engineering schemes are available from one source — Hawker Siddeley Engineering. Backed by the vast resources of the Hawker Siddeley Group this newly formed Division of Hawker Siddeley Industries Ltd. offers a service unequalled by any other organisation. The advantages of a single supplier with centralised control are now available for electrical power systems, sewage plant, harbour installations, radio telescopes, automatic railway control equipment, automatic warehousing, automated manufacturing plant and telemetry applications. This is "Automation with Muscles". Hawker Siddeley Engineering will engineer and develop any of these schemes, with or without automatic and/or remote control. We have representatives throughout the world. Please write for further information.

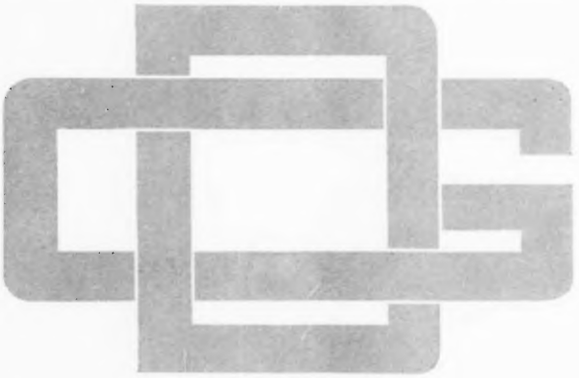
HAWKER SIDDELEY ENGINEERING

Duke's Court, Duke St., St. James's, London, S.W.1. Telephone: WHItehall 6177

GARDNER-DENVER 700 DRAWWORKS

Only Gardner-Denver, with its 100 years' experience in building every type of equipment for the oil field and industry, could have produced the completely new GD-700 drawworks. An eight speed, seven hundred horsepower unit, it is unparalleled in its depth class. The GD-700 design features short shafts that reduce bearing center distances . . . unit engineering of sprockets and chains to reduce wear . . . heavily reinforced side plates for rigid bearing support. Every component has been selected and engineered to produce a balanced drawworks that will operate with speed and low cost maintenance on drilling programs in the 5,000 to 10,000 foot range. □ The drawworks, transmission, controls, compound, engines and pump drives are mounted on a single main skid. When moving, only the auxiliary brake with its skid and the engines need be removed. Throughout the engineering of the GD-700, every drilling problem has been considered to assure the operator of a drawworks that is fast, safe and easy to move. □

The new Gardner-Denver 700 drawworks features: 330° wrap drum brakes □ Eight hoisting speeds and reverse □ Four rotary speeds and reverse □ Air controls for all rig operations □ All friction clutches mounted outboard □ Auxiliary positive Lo drum clutch □ Positive transmission clutches □ Centralized brake lube-center □ Hydromatic brake water level control at console □ Two package moving **GARDNER-DENVER**



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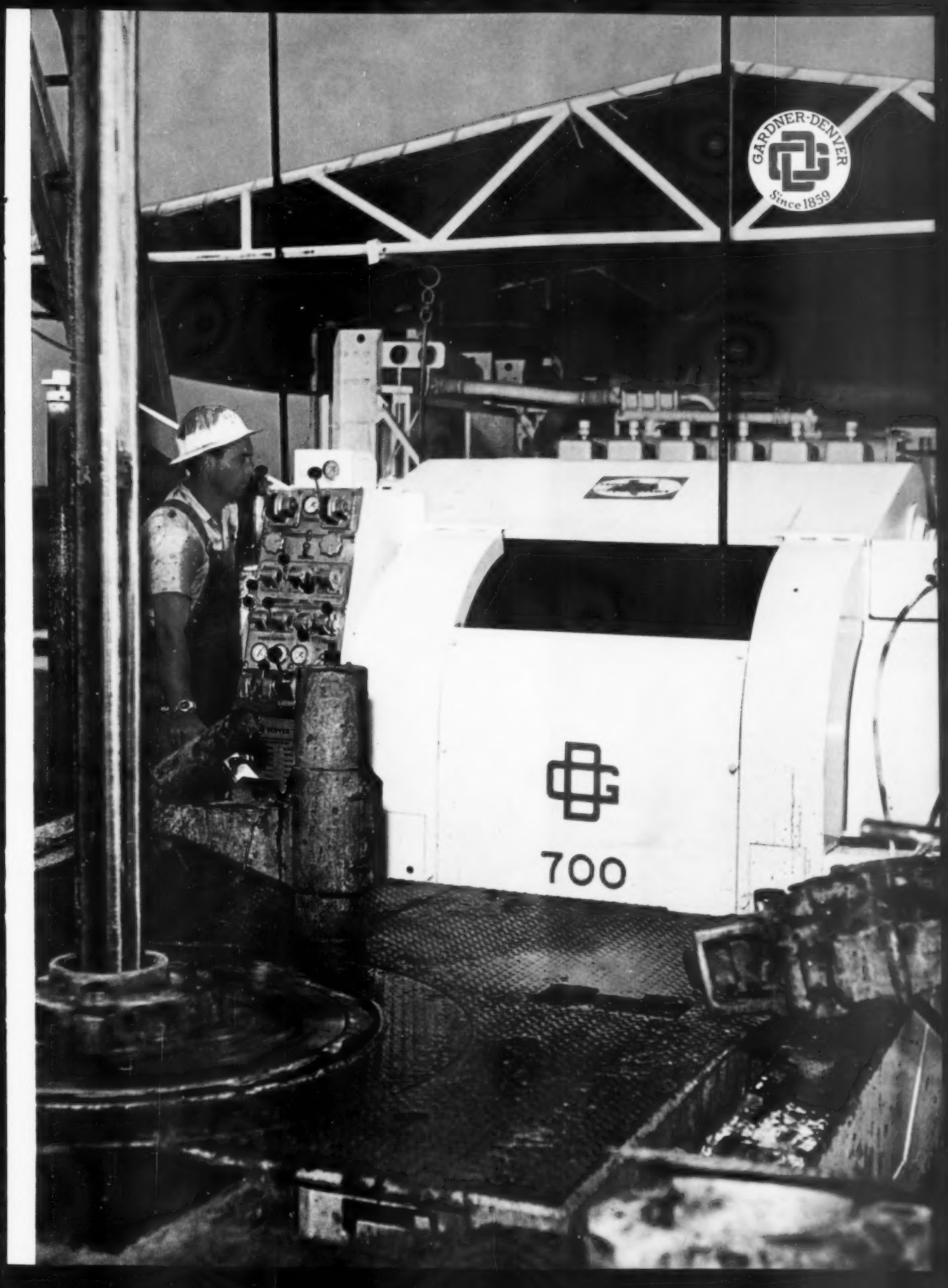
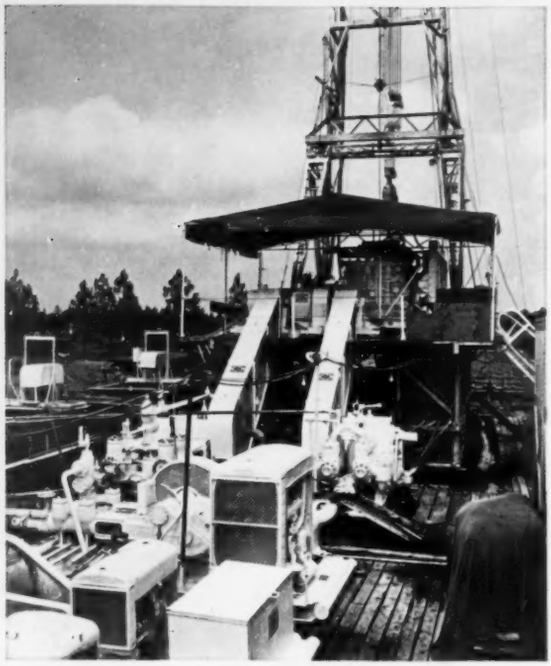

GARDNER-DENVER
Since 1859
700



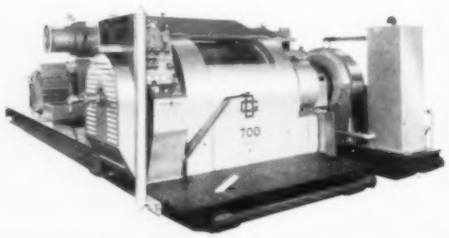
The GD-700 is a single skidded drawworks with all components mounted in line on the main skid section except the hydromatic brake and the engines. On location only these two elements need be rigged up to be ready for spudding-in.

The drum clutches and chains are mounted outboard where they may be easily serviced and inspected. Drum and brakes can be checked or inspected by removing the full width front panel. A unique tilting arrangement allows the driller's console to drop forward exposing valves and piping.

Trim-True
TRAVELING BLOCK 200 TON

Turbo-Lubricated
SWIVEL 200 TON

Turbo-Lubricated
ROTARY 17 1/2"



700
GARDNER-DENVER DRAWWORKS

Full line manufacturing from rotary table to mud pumps . . . Gardner-Denver drilling equipment has been designed as a matched team for greatest drilling efficiency. In addition to the drawworks, there is a swivel, block, rotary table, compressor and mud pump to match every drilling program.

GARDNER-DENVER Since 1859

Gardner-Denver equipment combines imaginative engineering and modern technology with a century of experience.

GARDNER-DENVER

U. S. A. Gardner-Denver Company, Quincy, Illinois. Offices in principal U. S., Canadian and Mexican cities. Petroleum Products: Dallas, Texas. **CANADA** Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario. **INTERNATIONAL** Gardner-Denver International Division, 233 Broadway, New York 7, N. Y. Offices: Buenos Aires, Argentina; Artarmon, N. S. W., Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal.

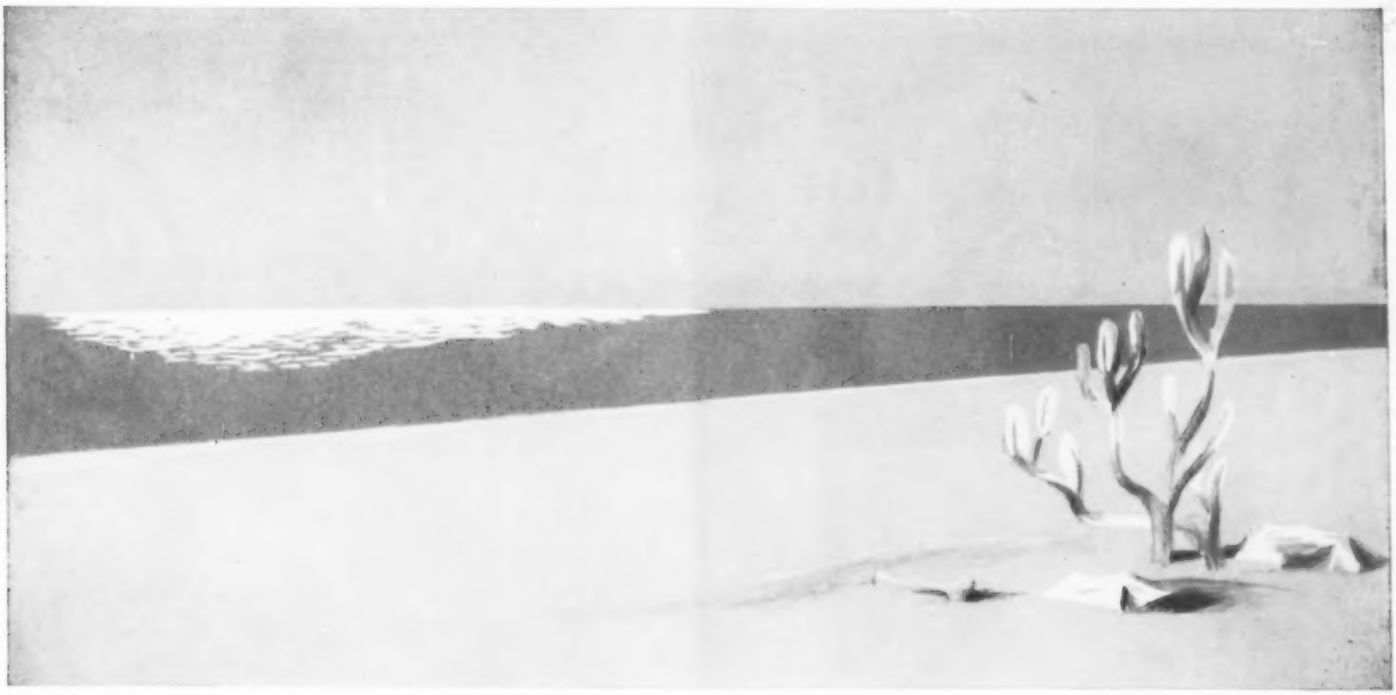
site for a town that drinks nothing but SEA

Sun-baked desert, parched and waterless—not a very promising site for a town. But, with the development of the Richardsons Westgarth multi-stage vacuum flash sea-water evaporator, it is now economically feasible for towns in arid coastal countries to draw all their fresh water from the sea.

These evaporators were pioneered in Great Britain by Richardsons Westgarth. The largest of them could distill 2,000,000 gallons of sea-water a day—enough for a town of 250,000 inhabitants—and the distillate is purer than many mains water supplies from conventional sources.

Richardsons Westgarth evaporators are at work in South America, the Middle East and elsewhere, providing fresh water for both domestic and industrial applications.

These units are at their most economical when used in conjunction with low-pressure steam or back-pressure turbines and, as manufacturers of most of the major equipment for power generation, Richardsons Westgarth are particularly well qualified to carry out completely integrated schemes.



R W G

RICHARDSONS, WESTGARTH & CO. LIMITED

The controlling Company of the RICHARDSONS WESTGARTH GROUP,

Wallsend, Northumberland, England.

In the U.S.A. and Canada: Richardsons Westgarth Inc. 1926 Eye Street, N.W., Washington 6, D.C., U.S.A.,

Telephone: Federal 82868

RW 70

INTERNATIONAL NEWS AND NOTES

ALASKA—Fourteen exploration wells have been, or are being, drilled for oil and gas under twelve development contracts signed since 1953 for Alaskan areas totaling 5,800,000 acres. The 12th is Pure Oil's six-year 399,000-acre contract in Kahiltna River area, about 60 miles northwest of Anchorage, calling for at least three more wells and expenditure of not less than $1 million.

ARGENTINA—Gas del Estado in Argentina is considering an offer by Saipem-Siderexport, an affiliate of ENI (Italian State Oil agency), to construct a 1,650-kilometer natural-gas pipeline for about $296 million. Line would run from Comodore Rivadavia to Buenos Aires. Address of Gas del Estado is 1169 Alsina, Buenos Aires.

ARGENTINA—By contract modification, Esso and Shell will receive new exploration and development acreage in areas where they have been unsuccessful during past two years. According to YPF's president Bruno, new areas under contract will be in Neuquen and La Pampa provinces. Initial agreements, made late in 1958, covered selected areas in Neuquen, Buenos Aires, and Rio Negros. Esso will receive total of 3,960,000 acres, inclusive of 467,000 from old contract areas.

AUSTRALIA—With permission of Australian government, Ohio Oil Co. and Continental Oil, through wholly-owned subsidiaries, have acquired exploration rights over an area covering 13,100 square miles (8.3 million acres) formerly held in northeastern Queensland by three Australian firms: Associated Australian Oil fields NL, Associated Fresnay Oilfields NL, and Papuan Apinaini Petroleum Co. Ltd.—subject to overriding royalty retained by the Australian firms. Ohio Oil International of Australia Ltd. will be operator. Concession provisions—Exploration Term: Initial four years, with right of one four-year renewal; Conversion: If oil discovered, right of conversion to initial 21-year mining lease, with 21-year renewals possible; Relinquishment: Whether oil is discovered or not, 25% of acreage must be returned to government by September 30, 1963. If renewal authorized, for three years beginning Sept. 30, 1965, 12½% must be relinquished each year. Ohio Oil and Continental, jointly with Amerada Petroleum, previously had acquired exploration rights over more than 11 million acres in Queensland, southwest of the new acquisition.

AUSTRALIA—South Australia's premier, Sir Thomas Playford has asked parliament for £A122,000 for duplicate oil-drilling equipment being used in the Great Artesian Basin on grounds that seismic studies of subsurface structures have proved very promising and the government is selecting drill sites.

AUSTRALIA—Of 89 applications under petroleum search subsidy act of 1959, 44 were approved in 1960-61. Nearly $3 million has been spent in subsidies to date. A total of 23 applications involved stratigraphic drilling; 47, seismic surveys; six, aeromagnetic surveys; two, bore-hole surveys. Refusals totaled 31 applications.

BOLIVIA—Bolivian Gulf Oil's Rio Grande-1 is another discovery on the company's 1,200,000-acre concession in the Santa Cruz area. It is located 35 miles southeast of Santa Cruz and 70 miles from Gulf's Caranda discovery (where the company has completed four oil producers and currently is drilling a fifth well). Rio Grande-1 flowed nine million cubic feet of gas per day through a ½-in. opening from 5,200 ft. Some condensate, a very light high-gravity oil, accompanied the gas. Company spokesman says additional drilling on the Rio Grande structure will be necessary to evaluate the gas-condensate discovery and to determine whether oil is present down the flanks of the structure.

BRITISH BORNEO—Annual revenues from Shell's operations in the independent sultanate of Brunei are expected to total $40 million in 1961—almost double what this 2,226-square-mile principality needs to support itself on the present scale. Brunei's investments abroad from surplus oil money—now said to total nearly $300 million—produce sufficient income to carry on the current rate of State expenditure indefinitely, even if the oil dried up—which it will in 10 to 20 years according to estimates of geologists. Brunei, a British protectorate, is making efforts to merge with the neighboring British crown colonies of Sarawak and North Borneo. Despite its heavy oil revenues, Brunei's general economy is at low level.

CANADA—First wildcat to be drilled in Canada's Arctic Islands was spudded September 10, 1961, by Peter Bawden Drilling Ltd. on Nelville Island for Dome Petroleum Ltd. group. Conductor pipe was set to 70 ft. through first section of permafrost. Surface-casing hole is 30-in.-diameter; is expected to go to 1,300 ft. to penetrate glacial drift. Drilling probably will be suspended in November on account of arctic night.

CANADA—Production of crude oil and gas liquids is now estimated as 641,035 for 1961, according to estimates of purchasers' nominations to end of December. Alberta will be dominant with 462,000, up 85,000 out of entire Canadian increase of 100,000.

CANADA—Crude oil exports are expected to average 180,890 for all 1961. This will be an increase of 58% or 66,568 over the 1960 average of 114,322. Three months out of last four this year are expected to exceed 200,000 with November setting peak of 219,035. Bulk of increase will be on Puget Sound—39,249 or 67% of whole gain.

CANADA—Most significant oil discovery of 1961 has been made by Pacific Petroleums, California-Standard and British American, at their Kaybob wildcat (1sd 10-4-64-18W5) 4½ miles east of the Kaybob oil field. Discovery well flowed 450 B/D on drillstem test in Beaverhill Lake member of Devonian Limestone at nearly 10,000 feet depth. Two rigs are being put on development drilling.

COLOMBIA—Colombian Petroleum Co.'s first commercial discovery since the Cicuco field in 1956 is the recent Bequete No. 1 well on Mompes Island in province of Bolivar. On a separate structure, six miles southeast of Colpet's Cicuco field, the discovery is expected to yield about 1,000 b/d when placed on production. Colpet hopes to ascertain size of new field from Bequete No. 2, also completed. As the new discovery is near Sagec pipeline from Tibu to Covenas, no new line will be required.

COLOMBIA—Cities Service, on its 75,000-acre block in the middle Magdalena valley, has brought in Payoa No. 2, a three-zone offset to its Payoa No. 1 discovered earlier this year. With total depth at 10,000 ft., Payoa No. 2 tested 2,200 b/d of 34-gravity crude from three zones between 9,400 ft. and 9,700 ft. Payola No. 2 is about 3,100 ft. south of Payoa No. 1 discovery, which had tapped five zones. Payoa No. 3 has been spudded about six miles southwest of Payoa No. 2.

COSTA RICA—Union Oil Co. of California's Cia. Petrolera de Costa Rica (50% Gulf-owned) was granted by the local government the 150,000 hectares which by contract the company had the right to apply for. A complete re-evaluation of all exploratory work done in Costa Rica is being made and, as soon as it has been finished, a decision will be made and a drilling program may be scheduled on one or more of the selected exploitation blocks. The drilling may be done under the Union-CaribGulf agreement of 1958.

FRENCH SAHARA—The recently completed 321-mile, 30-inch pipeline linking Ohanet field (25% Mobil International, 75% CEP) with input terminal of the 24-in. gravity-flow Hassi Messaoud-to-Mediterranean line will mark, late this fall, the second batch of North African crude starting to European markets. The Ohanet line will make Mobil the first USA company to have its own Algerian production. Throughput of line has not as yet been disclosed, but CEP (Ohanet operator) has completed 15 to 20 field wells, and has two rigs operating.

GABON—Wildcat Pambo N'Yango 1 by Mobil International Oil Co. was below 9,531 ft. as of Aug. 21, 1961. Mobil, for itself and French affiliate SPAEF, is soon to start a wildcat on a 3,191,000-acre marine tract—first offshore test in the Gabon.

GERMANY (East)—After many tries, commercial oil and gas in widely separated areas have been claimed by East Germany's Erdgascombinat (Oil & Gas Commission). A well near Reinkenhagen in the Pomeranian region is claimed recently to have discovered oil in a well at 7,200 ft rated at 560 b/d production. The wildcat originally had been projected to 12,000 ft in the Zechatein; but it encountered thick salt layers at shallow depth and difficulty from gas pressure. Well was then deviated and discovered oil.

GREECE—W. H. Hunt, of Dallas, Texas, several months ago began drilling at Platz, under his eight-year 4,700-square-kilometer exploration and development agreement signed September 22, 1960, calling for $6.4 million expenditure in Thessalonica. Hunt firm, which spent $500,000 in advance geological and geophysical prospecting, has hired French subcontractor Ferasol, who has 10 French technicians and 15 Greek laborers at work. Operation is under C. H. Guinn, Hunt's drilling specialist, and two American geologists. European drilling equipment is being used because transportation of a rig from USA would cost $100,000 against only $30,000 from Europe.

GREECE—Esso Hellenic's first drilling in Zante has reached 2,300 meters. Esso has already spent $1.5 million on exploration. Helies-Rap's second drilling in Thrace has gone to more than 1,500 meters—explaration thus far having cost $1.4 million. Firm's first drilling in Thrace proved dry. French Petroleum Inst. (operator for Greek government) before year-end 1961 will begin drilling at one or two locations in Epirus. A Romanian team will start drilling during 1961 in Kardistsa area. Aetoliki Petroleum Co., now prospecting geophysically in Aetoleakarnania, will start drilling in 1962.

INDIA—India (which gives priority in imports to machine tools, aluminum, fertilizers, and chemicals) shortly will open an investment center in the city of New York to promote flow of private USA capital into direct investments in India. Under India's five-year plans, certain industries are reserved to public ownership; others are placed in the private sector of the economy; while others include both public and private ventures. Generally, the foreign partner is asked to take a minority position, though India is not rigid about this.

INDIA—Preliminary talks indicate Belgium's national oil company is latest to offer collaboration with Indian government. The Belgians do not want prospecting concessions; they seek to drill on contract for India's National Oil & Gas Commission, similar to the French. Belgium would extend a loan or credit.

INDONESIA—After four years of negotiations, Asamera Oil Corp., a Canadian private enterprise firm, and PERMINA, an Indonesian State concern, have made an agreement whereby exploration and development of oil acreage in Indonseia will begin within about 90 days. The Canadian company will (1) furnish capital, equipment, technical assistance; and (2) recommend program for exploration and development in northern Sumatra. Asamora will be paid for its services and finances, and participate 40% in net profits. PERMINA's share of net will be 60%.

INDONESIA—Terms of the new 60-40 oil profits split (under which oil companies will operate as contractors to the Indonesian government) have not as yet been fixed; but it is understood they will vary somewhat with the three companies involved because of their different operating positions in Indonesia. Currently, combined crude production of the three international oil companies is about 420,000 b/d. (In addition, three State concerns formed after World War II have combined output of about 50,000 b/d.) Caltex, whose crude production is about 235,000 b/d, is estimated to have invested in Indonesia about $135 million—$120 million since end of World War II. Standard-Vacuum, with crude output of about 70,000 b/d, since war's end has spent about $80 million. Shell Indonesia, which accounts for approximately 115,000 b/d of crude, has invested heavily for (1) restoration of its war-damaged oil fields and refineries, (2) development of its new Borneo oil field, (3) build-

(*Continued on page* 110)

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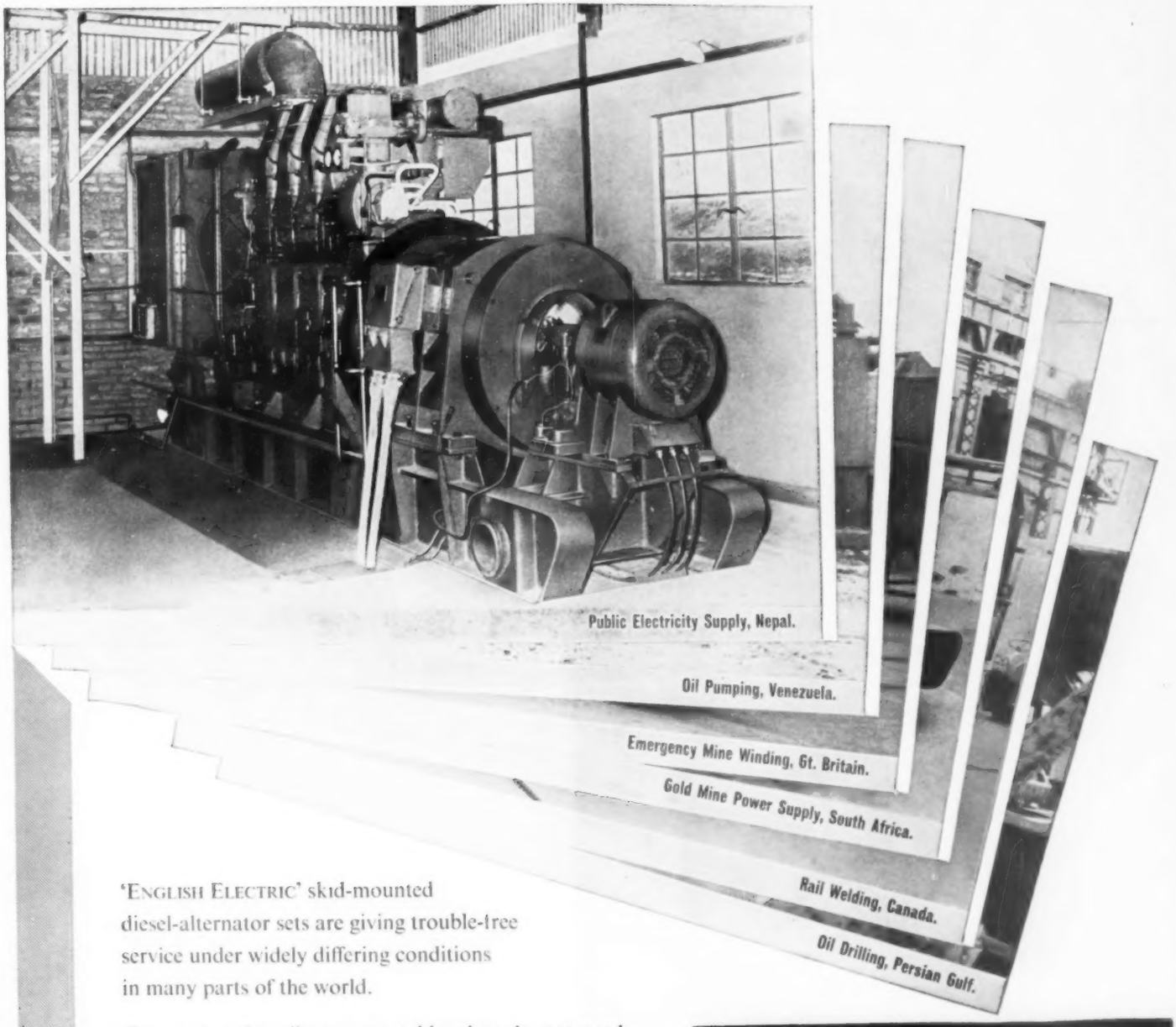
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(Continued from page 108)

ing of a 160-mile pipeline from that field to Balikpapan refinery.

ITALY—Standard of New Jersey has filed in US federal court a $53,120,000 damage suit against the Italian company ANIC SpA which last spring asked damages of $20.5 million in connection with alleged unsatisfactory process work performed by SONJ on two refineries in Italy, one at Bari and the other at Leghorn. SONJ categorically denied the charges, and its suit is a counterclaim for damages the international oil company claims it has suffered as result of false allegations by the Italian company.

JAPAN—A Russian trading mission was expected in Japan late in September to negotiate a five-year purchase (beginning in 1963) of steel pipe worth $150 million, plus machinery worth $100 million, for the 2,622-mile trans-Siberian pipeline to run from Krkutsk in central Siberia to Nakhodka on the coast of the Sea of Japan. Eight Japanese firms are said to be involved, including Nissho Co., which made the announcement.

KUWAIT—With construction to begin this coming winter and scheduled for May 1962 completion is a new 22-in. to 26-in. 100,000 b/d gravity-flow crude pipeline by Kuwait Oil Co. (owned 50-50 by Gulf and BP). It will connect the Minagish oil field in southern Kuwait with storage tank farms at Ahmadi.

LIBYA—Composition of the new National Oil Co. of Libya, which was slated for incorporation in Tripoli early in August, is believed to have approval of Libyan government and possibly to establish a new operating pattern for the country. With international "cooperatives" ranging from Stockholm to McPherson, Kans., and with prominent Libyans (not as yet identified), the USA oil firm Kewanee Oil Co., of Tulsa, is to be operator. Anis Qasim, a member of Libya's first petroleum commission, has been mentioned in connection with the venture, as well as Dr. Nadim Pachachi, an Iraqi recently employed by the Libyan government as an oil consultant, and credited with having organized the new company.

LIBYA—As part of a program to test Libyan crude in European plants in advance of completion of terminal at Marsa el Brega, first Zelten crude recently got on its way to Fawley, England, in the partly loaded 26,000-ton tanker "Esso Canterbury."

NEUTRAL ZONE — Supplemental agreement between American Independent Oil Co. and Ruler of Kuwait signed July 20, 1961, provides the oil company will be subject to Kuwait income taxes. Payments to the ruler will be either 50% of oil profits or 57% of oil income, whichever is greater.

NIGERIA—California (Nigeria) has filed articles of incorporation with the corporation department of the Secretary of State's office in Dover, Del., listing authorized capital stock of 1,000 shares of no par value, to deal in refineries.

PAKISTAN—After detailed surveying of area for several years, Pakistan Shell Oil has begun Kailas Tila No. 1 test, 10 miles east of Sylhet in East Pakistan. Well is projected to 13,000 ft.

PAKISTAN — Presidential cabinet has approved formation of an oil and gas corporation to coordinate to coordinate countrywide oil and gas exploration as well as the training of Pakistan is in the field. Enabling legislation detailing terms and reference is expected shortly.

PAKISTAN—A three-year exploration license covering 813.5 square miles in Makran and Kharan districts of Kalat Division, West Pakistan, has been granted Tidewater Oil Co.

SYRIA—(thus far not an oil producer) claims it will be moving 40,000 b/d of crude by pipeline to the Mediterranean by mid-1964 from its two lone fields, Karatchuk and Suwaida, under its five-year plan begun in 1960. Syria's General Petroleum Authority claims country's reserves are more than a billion barrels.

SYRIA—Tecknit, an Italian firm which conducted a preliminary survey, is supervising construction which has started on a 510-kilometer 6-in. products line scheduled for 1962 completion. Running from the refinery at Homs, the line will deliver some 300,000 ton/yr of gasoline, kerosine, and diesel oil to Aleppo; 250,000 tons to Damascus; and 350,000 tons to and from the port of Latakia. Eight pumping stations are to be installed at Homs and other units at Latakia and Tartous.

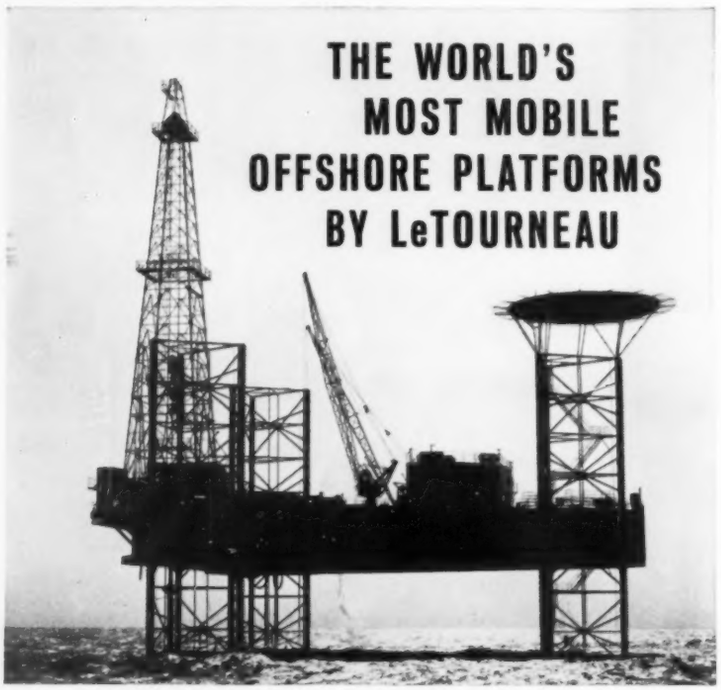
USSR—A volcano on an island 25 miles southwest of Bako (believed to have been inactive for past 100 years) recently erupted—bringing up mud, volcanic rock, and natural gas—which then caught fire. Russian geologist Baba-Sade sees in this another indication of large oil and gas deposits beneath Caspian Sea. Thus far 600 oil deposits have been identified in Soviet Union, but 60% of Soviet reserves are concentrated in eight areas only.

USSR—When the now half-completed 2,800-mile Comecon crude pipeline linking Russian oil fields with refineries under construction in Hungary, Poland, Czechoslovakia, and East Germany is complete some time in mid-1962, Red planners claim the line (known as the "Friendship Pipeline") will cut oil costs for the satellites. For instance, Hungary (which now receives 96% of its crude from Russia) figures it will recover its $12.5 million share of the pipeline's cost in two years' time through oil transportation savings. (Czechoslovakia depends on Russia for 99% of its crude; and Bulgaria imports a substantial proportion of its crude from Russia). A petrochemical buildup in these satellites is part of the program to weld the trade and economies of these Eastern European countries with Moscow.

USSR—According to a translated scientific report in hands of US Commerce Dept., Russian scientists plan to drill an oil well at least eight miles into the earth —three miles deeper than Phillips Petroleum's record 1958 Pecos County, Texas, dry hole which went to 25,328 ft, thus far the world's deepest drilled hole. Russians do not expect to find intact oil at the eight-mile depth, but hope to tap deposits on the way down. The experimental well is to be bored by a new diamond drill now under Soviet test; and ordinary steel pipes will be replaced with light-weight-alloy heat-resistant high-strength steel pipes.

VENEZUELA—Soviet oil will not pose a threat to his country, said Venezuelan oil minister Juan Pablo Perez Alfonzo in Caracas after a recent visit to the USSR. The estimate of a million barrels daily exported to the Western world by the Russians by 1970 is too high, says Perez, it will scarcely reach 800,000 b/d—and such an increase, he says, is not important in view of generally increasing demand and consumption.

WORLD—US Commerce Dept. estimates investment abroad by all USA companies during 1961 will be 20% higher than in 1960. Total outlay for plant and equipment is estimated at $4.5 billion, with same expected for 1962. Oil companies during 1961 expect to spend $1.8 billion abroad, well below the 1957 record of $2.3 billion.



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Nomads Guests from Abroad

International guests at a recent meeting of the Los Angeles Chapter of Nomads. Left to right (back row) Valerio Rivadossi of SNAM from Italy; A. Silvestri of SAIPEM from Italy; Richard J. Bujak of Fagro from Austria; Fred Lay of Camdrill from Libya; R. C. Woods of Ralph M. Parsons Co. from Kuwait; (front row) Giorgio Cassone of AGIP from Italy; Francesco Grubas of AGIP from Italy; George A. Waters of Ralph M. Parsons Co. from Ethiopia; M. F. Burgett of Camdrill from Libya.

Atlantic Acquires Frank Chemical

The Atlantic Refining Co. has acquired a majority interest in the J. P. Frank Chemical and plastic Corp. The Frank corporation, with manufacturing facilities in Brooklyn, New York, produces polyvinylchloride resins, co-polymer resins, films, and sheeting; polyethylene film; and plasticizers and stabilizers. It also embosses and prints the films and sheeting. According to Henderson Supplee, Jr., Atlantic's president, this move, which represents one of the initial steps in Atlantic's diversification program, will broaden and accelerate its participation in the chemical field.

Imports Program Good to Venezuela

Venezuela is doing nicely under the USA oil import program according to Sen. John Sherman Cooper, R., Ky., in a reply to opponents of curbs on residual fuel oil.

In 1958, he said, Venezuela shipped 84.9 million bbl of residual to the USA. In 1959, it was 100.5 million, and by 1960, it rose to 113.7 million bbl. The price of the oil has remained at $2 bbl he said, so the value of the exported oil was 889.9 million in 1959 and $948.3 million in 1960. Venezuelan shipments of crude oil to the USA climbed by 9 million bbl from 1958 to 1959, he added. During this time, Venezuelan purchases from the USA dropped by about $190 million.

New Esso Tanker

The largest ship ever built in Holland, a tanker of 77,000 dwt, was launched recently at Verolme United Shipyards for Esso Petroleum Co., London.

With an over-all length of 855 ft, the ship when completely filled will be able to carry 3,478,000 cubic ft of cargo in thirteen center tanks and two rows of thirteen wing tanks. The ship will be unusual in that there is no dry cargo hold forward. Its displacement is 99,680 tons and its speed approximately 17.5 knots. The main propulsion machinery will be a Pametrada-Werkspoor steam turbine plant, capable of developing a total maximum output of 26,500 SHP at 108.5 revolutions per minute of the propeller.

GSI Reorganizes

Geophysical Service Inc.'s Gulf Coast and Southeastern operations have been combined into Eastern Operations, with G. A. (Jim) Howard as manager.

Recent increases in domestic offshore work prompted the formation of a section which will handle those operations exclusively. The new section will be headed by T. P. Ellsworth, formerly manager of operations on the Gulf Coast.

Gault Promoted by Republic

Frank E. Gault has been appointed assistant manager of sales for the pipe division of Republic Steel Corp. He has been vice president in charge of sales for Republic Supply Co., Oklahoma City, and was for several years vice presiednt of Murray Brooks, Inc., Lake Charles, La., before that company was acquired by Republic Supply last February.

World's Largest Boom

Two of the four twin 12-in. balanced boom tanker loading units being engineered and manufactured by Woodfield Rochester Ltd. for Basrah Petroleum's new deepwater terminal at Khowal-Amaya, off Fao, were demonstrated recently at the maker's Frindsbury Works, Rochester (Kent).

Designed by Rendel, Palmer & Tritton, consulting engineers, London, these units are claimed to be unique and to be in advance of anything either in Europe or in America and, with an approximate weight each of 80 tons, to be the largest made anywhere for tanker loading duties.

Crude oil loading capacity at each of the two berths was laid down at a minimum of 7,000 tons an hour. Special features are incorporated in the design to accommodate weather conditions which cause tankers to range and drift as well as rise and fall. Other special features permit operation with minimum manpower and the units have automatic luffing devices which allow them to be left unattended during the loading period.

BP Pays 20% Stock Dividend

The board of directors of The British Peroleum Co. Ltd., has recommended that the ordinary share capital of the company be increased by 50,000,000 new shares of £ 1 each, and that a stock dividend in the proportion of one new ordinary share for each five £ 1 stock units be distributed to stockholders of record on September 15, 1961. An extraordinary general meeting of stockholders was held October 26, 1961, to give effect to this and other board recommendations.

In regular dividend action, the board declared, in respect of the results for 1961, an interim dividend of eight pence (approximately 9 cents) per ordinary stock unit of £ 1, payable, free of United Kingdom income tax, on November 4, 1961. A similar interim dividend was declared in September last year.

New A.A.P.G. Officers

Leo R. Newfarmer, Shell Oil Co., Houston, and Robert E. Rettger, Sun Oil Co., Dallas, are the American Association of Petroleum Geologists' candidates for Association presidency during 1962-63. Other officer-nominees are: for vice president, Orlo E. Childs, Phillips Petroleum Co., Denver, John A. Downing, Link, Downing, Cooke and Co., Ltd., Calgary, and John M. Hills, consultant, Midland, Tex.; for secretary treasurer, Jackson M. Barton, Northern Natural Gas Prod. Co., Omaha, Neb., Robert E. King, American Overseas Petroleum Ltd., New York, N. Y., and Irving T. Schwade, Richfield Oil Corp., Los Angeles; and for editor, Grover E. Murray, La. State Univ., Baton Rouge.

Foxboro to Expand at Montreal

Plans for a $600,000 addition to the Montreal plant of The Foxboro Co., Ltd., have been announced. Contracts have been signed and actual construction will start soon on the firm's 12-acre site. It is expected that the building will be ready for occupancy early next spring.

The new two-story structure will give the plant a total of 110,000 square ft, permitting a substantial increase in the production of Foxboro instruments supplied to the process industries of Canada and to export markets as well.

McKee Forms Executive Committee

Formation of a three-man executive committee to direct the operations of Arthur G. McKee & Co. and its subsidiaries has been announced. Chairman of the committee is H. R. Moorhouse, executive vice president and treasurer since 1958, who has been named administrative executive vice president. The other two members are Merrill Cox, formerly vice president of sales for the company's Metals Division, who has been named executive vice president responsible for all activities of that division and William B. Hudson, who has been named executive vice president responsible for all activities of the Petroleum and Chemicals Division. Hudson formerly was vice president of refinery engineering.

K & M Licenses Brazilian Firm

Kieley & Mueller, Inc., Middletown, New York manufacturer of control valves, has announced the signing of an agreement licensing the Brazilian firm, Sidel—Comercio E Industria S/A, to manufacture its complete line of automatic control valves and level controllers. The Brazilian company is located in Rio de Janeiro at 39 Avenida Franklin Roosevelt. Sidel—Comercio E Industria will manufacture the K & M product line for the entire South American market. The company also is the authorized K & M sales representative in Brazil.

Oilfield Hauling Trucks

International heavy-duty trucks for all phases of oil field hauling are the subject of a 12-page catalog available through the International Harvester Export Co., 180 North Michigan Ave., Chicago, Ill. Size and type vehicles to meet every specific job requirement are featured. Please request catalog E-122-L.

New Drilling Fluid System

Already proved successful in over 300 wells, a newly developed experimental drilling fluids system is now being introduced generally in all drilling areas by Magnet Cove Barium Corp. (Magcobar), Houston, Texas.

The new system combines a newly developed material, called XP-20, with the company's "Spersene," a chrome lignosulfonate dispersant. The result is a chrome lignitechrome lignosulfonate mud that is simple to prepare and maintain.

The basic ingredients of the new system called XP-20/Spersene, are water, bentonite, barite, caustic soda, chrome lignite, and chrome lignosulfonate. Despite this simplicity, the mud is unusually stable under high temperatures and high pressures, has outstanding filtration characteristics, retards the natural swelling of drilling solids, and has excellent tolerance for contaminants.

Foxboro Names Huckman

Edward R. Huckman has been named general sales manager for the Foxboro Co., Ltd. He will have charge of all industrial instrument sales activities for the Montreal firm and its branch offices in St. John, Toronto, Sudbury, Port Arthur, Edmonton, Calgary and Vancouver.

A graduate of the Massachusetts Institute of Technology with a B. S. degree and veteran in the field of process measurement and automatic control, he originally started his instrument career in 1927 at the main plant in Foxboro, Mass. For the past three years he has been assistant field sales manager for the U. S. sales organization.

Farris Appoints Stillman

The appointment of Lee P. Stillman as vice president of Farris Engineering Corp., has been announced by Victor W. Farris, president of the Palisades Park, N. J., firm which manufactures safety and relief valves, flexible valves, steam traps and valve testing equipment.

Stillman had served with Manning, Maxwell and Moore for 22 years where he held successive positions of sales Engineer, product manager, works manager and manager of the Tulsa product division.

UOP Names Widowit

Adolph H. Widowit, Jr., has been appointed manager of advertising at Universal Oil Products Co., Harvey W. Blankenship, director of public relations, has announced.

Advertising assistant to Blankenship for the last three years, Widowit will be responsible for the company's advertising programs and will cooperate with UOP subsidiary companies in their advertising programs and more particularly as such programs relate to the parent company's advertising activities.

Milwhite Transfers Shults

Milwhite Mud Sales Co. has transferred Neal Shults to Dallas, Texas as their new representative there. Shults has been associated with Milwhite and Milwhite Products since 1955, having worked for Basin Mud Co. in Midland (a Milwhite Distributor). In 1957 Milwhite purchased Basin Mud Co. and Shults continued to serve in the capacity of business manager and sales from that time until his transfer to Dallas.

Crane Enters Australia

Crane Co. chairman T. M. Evans announced that the company will establish a manufacturing subsidiary in St. Marys, an industrial area near Sydney, New South Wales, Australia. The facility to be built will produce valves, water meters and pumps. The plant will be staffed by Australians.

Du Pont Names Diggs

Donald R. Diggs has been appointed assistant to the technical manager of Du Pont's Petroleum Chemicals Division. Dr. Diggs, whose 11-year career with Du Pont has been in the field of combustion research, will be concerned primarily with following developments relating to the control of automotive exhaust and coordinating the Petroleum Chemicals Division's technical efforts in this area.

Petrochemical Pipelines

Air Reduction Co. will build a 22-mile nitrogen pipeline and a stainless steel oxygen line from a Claymont, Del., gas recovery plant to nearby petrochemical plants. Airco will deliver 100 t/d of oxygen and 150 t/d of nitrogen to the Sun Olin ethylene oxide plant. Shell Chemical and du Pont will take another 100 t/d of nitrogen. Sun Olin will supply Airco with raw hydrogen for purification and resale in liquid form.

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Readily adjusted or reset, both high and low pressure settings on Safomatic Valves may be changed in a matter of minutes while the valve is in service and under pressure. Just as easily, the balanced stem design permits manual resetting.

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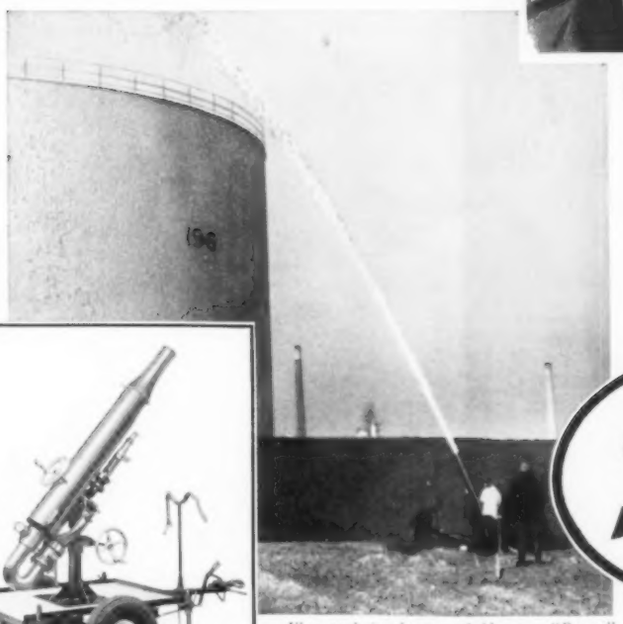

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NEW PUBLICATIONS

"History of Petroleum Engineering" is a 1,230-page volume, described as the world's first comprehensive historical chronicle of the concepts, methods and equipment employed in the drilling for and the production of oil. It represents ten years of research and organization under the leadership of the Division of Production of the American Petroleum Institute.

Essentially a history of American petroleum engineering from the 1800's to the present day, the book also contains numerous and extensive references to foreign developments, including those of centuries ago. It contains 21 chapters, 498 illustrations, and the documentation lists 1,782 bibliographic and patent references.

Chapter subjects, and authors, are as follows:

"The Energy Revolution," by James A. Clark, petroleum historian; "Concepts on Occurrence of Oil and Gas," by the late E. DeGolyer, petroleum geologist and historian; "Sources of Men," C. A. Warner, engineering and geological consultant; "Evolution by Companies," John R. Suman, former vice president, Standard Oil (New Jersey); "Percussion-Drilling System," J. E. Brantly, former president, Drilling and Exploration Co. and author and editor, *The Rotary Drilling Handbook*.

Also: "Rotary Drilling System," J. E. Brantly; "Cementing," C. V. Millikan, former chief engineer, Amerada Petroleum Corp.; "Logging, Sampling and Testing," E. G. Leonardon, director, Schlumberger Well Surveying Corp.; "Completion Methods," Harold Vance, vice president, Bank of the Southwest; "Production Equipment," C. J. Coverly, president, Kobe, Inc.

Also: "Production Techniques and Control," H. C. Fowler, research director, US Bureau of Mines Bartlesville Petroleum Research Center, and C. E. Reecher, former research and development director, Cities Service Oil Co.; "Reservoir Engineering," Carl E. Reistle, Jr., president, Humble Oil and Refining Co.; "Fluid Injection," James A. Lewis, president, James A. Lewis Engineering Co.; "Thermal, Solvent and Improved Gas-Drive Oil-Recovery Methods," Lloyd E. Elkins, production research director, Pan American Petroleum Corp.; "Handling Oil and Gas in the Field," T. E. Swigart, chairman, North Central Oil Corp.

Also: "Evaluation," Harold Vance; Drilling and Production Research," Lloyd E. Elkins; "Conservation," Rex G. Baker, former vice president and general counsel, Humble, and Robert E. Hardwicke, attorney; "Unitization," Herman H. Kaveler, consultant; "Standardization of Oil Field Equipment," C. C. Scharpenberg, former chief engineer, producing department, Standard Oil of California; and "Impact Upon Society," D. V. Carter, division engineering manager, Mobile Oil, who also served as chairman of the editorial board for the *"History of Petroleum Engineering."*

Copies, at $10 each for USA shipment and $11 for foreign shipment, may be ordered from: Division of Production, American Petroleum Institute, 300 Corrigan Tower Bldg., Dallas 1, Texas.

"Correlation Method of Refracted Waves," is a 342-page manual, recently translated from the original published by the USSR Academy of Sciences in 1952. The translation has been released by the Office of Technical Services, Business and Defense Services Administration, U. S. Department of Commerce. It is described as a systematic, comprehensive geophysical study of the development and application of a technique devised by Soviet scientists as an aid in Russia's search for new petroleum, coal and ore deposits. This "manual for seismologists" may be obtained by ordering 60-11607 from the OTS, U. S. Dept. of Commerce, Washington 25, D. C. Price, $3.50.

A new edition of the safety manual, *"Cleaning Tanks Used for Gasoline or Similar Low-Flash Products,"* issued by the American Petroleum Institute, covers the use of suitable mechanical equipment and protective clothing, use of proper cleaning methods, elimination of potential ignition hazards, and provisions for means of entrance and exit in an emergency. The instructions apply not only to gasoline storage tanks, but also to tanks used for such products as JP-4 jet fuel, naphthas, some solvents, and special tractor fuels.

Orders for API Bulletin 2016, Fourth Edition, should be directed to the Institute's Publications Department, 1271 Avenue of the Americas, New York 20, N. Y. Price, $1 per copy.

A major article in the new *ASM Metals Handbook*, 8th edition, Vol. 1, "Properties and Selection of Metals," deals exclusively with selection of steel for high temperature service in petroleum refinery applications. It begins with a consideration of material standardization, specifications, and codes, and then proceeds to a careful analysis of the metallurgical factors affecting the uses of carbon, low-alloy, intermediate alloy, and stainless steels.

A total of 51 charts and 13 tables are presented, including actual operating data obtained in refineries. Specific case histories clarify many problems encountered in materials selection and utilization. For example, one table contains extensive service data on a fluid catalytic cracking unit, summarizing the service experience of individual parts of major components. Corrosion and corrosion rates are provided the same exhaustive treatment. Various tables and charts contain service data on the corrosion rates of steels in lube, crude, and vacuum flash units handling crude oils that contain naphthenic acid, the corrosion resistance of various metals in a two-stage vacuum tower (based on a 375-day test), comparison of metal losses due to scaling, and reforming unit data on rates of carburization.

This section was prepared by an ASM committee on the subject, headed by Dr. Carl H. Samans, national trustee of the Society and director of the Engineering Metals Div., Research and Development Dept. American Oil Co.

The complete Metals Handbook contains 1,300 pages, 6,700 illustrations, 1,841 tables, and data compilations of 456 alloys. Order from the American Society for Metals, Metals Park, Ohio. Price, $30.00.

"Chem-Petro Guide — Asia, Africa, Australasia," provides a directory of chemical and petroleum firms in 43 different countries in the regions indicated by the title. It gives name, street address, ownership, affiliated firms, plants, and products. Order from Noyes Development Corp., 38 East 57th Street, New York 22, N. Y. Price $12 postpaid.

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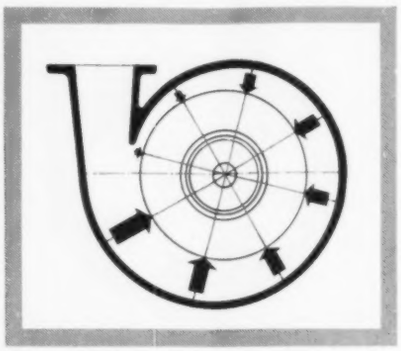

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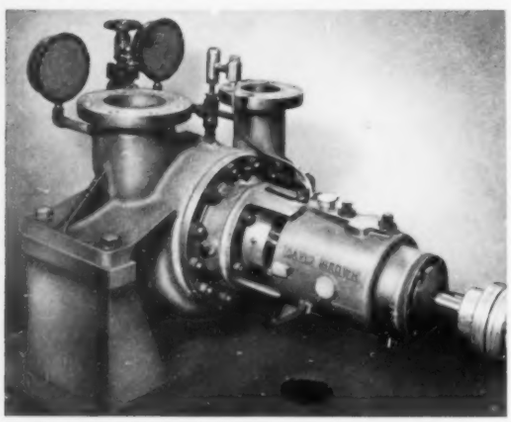

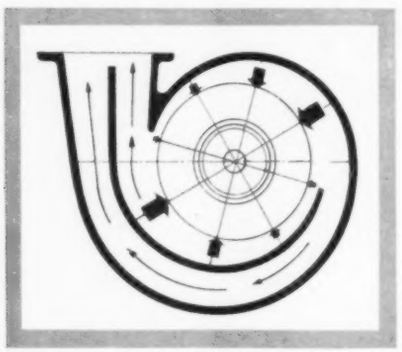

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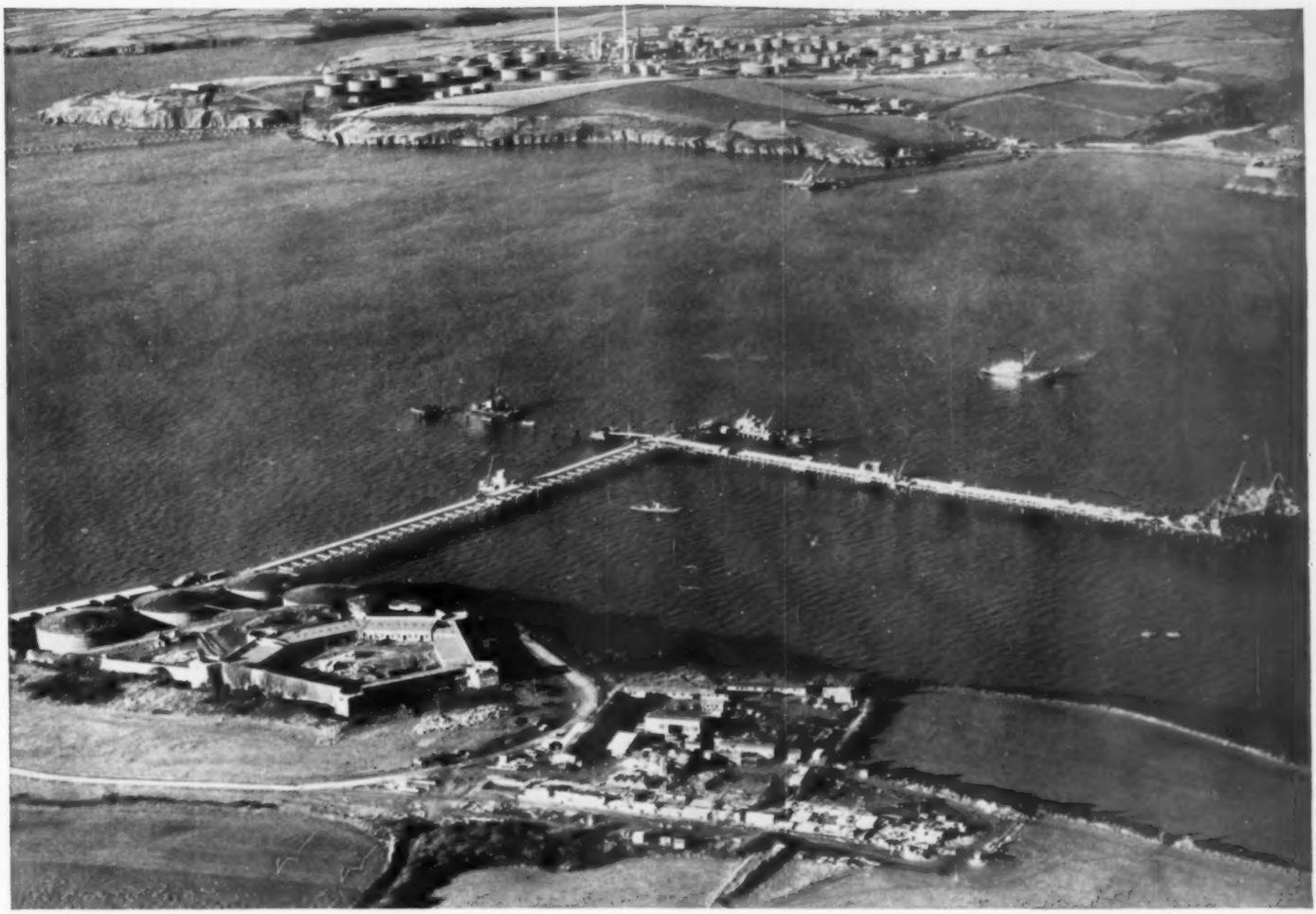

Angle Bay, Milford Haven. Photograph by courtesy BP Company

Hydrographic surveys for the Oil Industry

All preliminary hydrographic survey work in connection with the new British Petroleum Company's super tanker oil terminal at Angle Bay, Milford Haven, was carried out by Kelvin Hughes acting on the instructions of the Consulting Engineers, Messrs. Rendel, Palmer & Tritton. When completed this terminal will provide deep water facilities capable of berthing ships of 100,000 tons d.w.

Hydrographic surveys of every description are undertaken by the Kelvin Hughes Contract Survey Department.
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Ball Associates Merger

Dan Turner and Associates, Inc., has consolidated with Ball Associates, Ltd. Business will continue as Ball Associates, Ltd. in the Johnson Building, 509 17th Street, Denver. Dan Turner and Associates specialized in geological and evaluation consulting in the Rocky Mountains. Ball Associates, headed by Douglas Ball, president, specializes in geological problems, particularly those that need an engineer, economic approach. Under Dr. Werner F. Schneeberger, vice president of exploration, it has undertaken exploration in many parts of the world. It has served many pipeline and utility companies, both domestic and foreign, in the development of underground gas storage.

CGG Introduces "Exploder"

Cie Generale de Geophysique and Marine Geophysical International Inc. of Houston (Texas) have completed arrangements whereby the services of the "Gas Exploder" may be available to C.G.G.'s clients in Common Market, Mediterranean Basin and French-speaking African countries. Under these arrangements, equipment is provided by Marine Geophysical; general operations control and geophysical interpretations by C.G.G.

The Gas Exploder is a marine or fluvial seismic reflection profiling system with an explosive mixture of propane and oxygen as seismic source. The original application of this principle for scientific investigations has been realized by the Lamont Geological Observatory. Improvements and adaptation to petroleum exploration have resulted from Marine Geophysical's use of the method in various water-covered areas.

The seismic shots are repeated at regularly spaced time intervals every 2 or 4 seconds; the shots are triggered at zero time on the record. Reflected signals from each shot are recorded adjacent to each other on the record. The record thus produced is in essence a geological cross-section. The horizontal scale is the distance along the survey boat's track, and the vertical scale is vertical time (depth).

Two types of gas gun systems have been used for the Gas Exploder. The actual system consists of 2 guns 3 ft in length by 4 in. inside diameter, beneath the water surface. They are fired simultaneously at a repetition rate of once every 4 seconds. These guns are towed immediately astern of the survey boat. The recordings are taken with a band pass filter setting of around 30-60 cycles per second. Continuous reflections are obtained to depths of 4,000-6,000 ft from the bottom of the water.

Due to simplicity of operations and elimination of elaborate equipment and explosives, the cost of a Gas Exploder survey is much lower than the cost of conventional seismic surveys.

Dr. S. D. Koonce

Koonce Appointed by Lummus

Dr. Samuel D. Koonce has been named to the newly-created position of manager of commercial development for The Lummus Co.

Dr. Koonce joined Lummus after six years as manager, market research department, Commercial Development Division, American Cyanamid Co. Previous positions were with the Jefferson Chemical Co., Distillation Products, Inc., and Innis Speiden & Co.

Padberg Joins Emerson

Louis R. Padberg, Jr., formerly an electronic scientist with the U.S. Navy Electronics Laboratory, is now scientific director of Emerson Electric Manufacturing Co.'s electronic acoustic research division in Santa Barbara, Calif. WORLD PETROLEUM's March, 1958 issue (Vol. 29, No. 3) contained a report by Mr. Padberg on a new approach to geophysical exploration using sonic frequencies. The March, 1962, issue will contain a follow-up article reviewing the applicability of the underwater electric spark as a broad-band source competitive with chemical explosives. Further progress will also be reported on a pneumatic narrowband low frequency source.

Brown Hits Seven Million

The seven million ft mark has been reached by Brown Drilling Co., California oil well drilling contracting firm. The mark was set by Brown's Rig #6 as the company drilled its 1,427th well.

Founded in 1937, Brown Drilling Co. has been very active in California, and recently, particularly active in the Northern California gas fields, with six rigs working. A complete field headquarters is maintained at Woodland, Calif. In addition to California operations, the company has been active in South and Central America, Turkey, Australia, New Zealand, France, and Arabia. One firm subsidiary is now drilling in the ocean off Seal Beach, Calif., and an associated company, International Brown Drilling Corp., is active in Guatemala.

Personnel Changes

JEAN B. DUMON appointed president director general of Burgess-Manning, International, S.A., Paris, France.

G. S. LEONARD to manager of manufacturing, Pressure Control Equipment Division of Cameron Iron Works, Inc.

JOHN N. BREWSTER, manager of petroleum company sales for B. F. Goodrich Tire Co. for the past two years, has gone to Melbourne, Australia, as sales manager for B. F. Goodrich Australia Pty. Ltd., a B. F. Goodrich subsidiary.

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FERTILIZERS FOR THE MEXICAN FIELD

Before the end of this year two 200-ton a day anhydrous ammonia plants will be put on stream in Mexico, and a third one of equal capacity is to be installed in the near future to complete the fertilizer branch of the basic petrochemicals division of Petróleos Mexicanos (PEMEX). The first of two dodecilbenzene plants has been in operation since March 1960, and other units are in course of construction to produce aromatics, plastics, fibers, tetraethyl lead and basic materials for synthetic rubbers.

One of the ammonia plants is located in Minatitlán, a river and sea port on the Gulf of Mexico at the Isthmus of Tehuantepec, near the southern gas fields and side by side with an oil refinery. It is intended to supply ammonia to private operators and to export its surplus production. Initial operation started in the middle of October.

"Fertilizantes del Istmo, S.A.", a private firm now initiating their industrial activity, is producing nitric acid and nitrate of ammonia on the basis of PEMEX supply, and as soon as additional equipment is ready to operate they will produce sulphuric acid, triple superphosphate and urea, importing their phosphoric rock from Florida. These fertilizers will be distributed along the Pacific and Gulf coasts of Mexico and shipped abroad.

The second ammonia plant will go on stream in December. Its location in Salamanca, the center of a most important farming area, offers a natural domestic market for fertilizers although gas comes to the plant from the same southern gas fields, 649 miles away, through a new gasduct now in operation.

Also in this case private interests coordinate their activities with PEMEX to bring final products to the farmer. Half of the anhydrous ammonia production will be taken over by "Fertilizantes del Bajío, S.A." to manufacture urea, and the rest will go to several smaller firms to mix various formulae of solid fertilizers, or to distribute the original product among croppers.

Both plants are designed for growth as the increases in demand require. Additional 200-ton units will be installed to enlarge production of anhydrous ammonia on either of the two locations or on both of them. Planning is based on the convenience of building large, modern and efficient plants to be operated at the lowest possible cost per ton.

Engineering and supervision of construction for the Minatitlán plant was in charge of the Lummus Company, and the Fluor Company took the responsibility of the Salamanca unit.

One of the great problems of Mexico is land exhaustion due to century old cropping on unfertilized soil, many of the areas being one-crop lands. The program developed by PEMEX in cooperation with private enterprise, with a view to provide the farmer with abundant supply of varied fertilizers at reasonable prices, will offer a way out to Mexican agriculture pressed for larger and more diversified production by a fast growing population.

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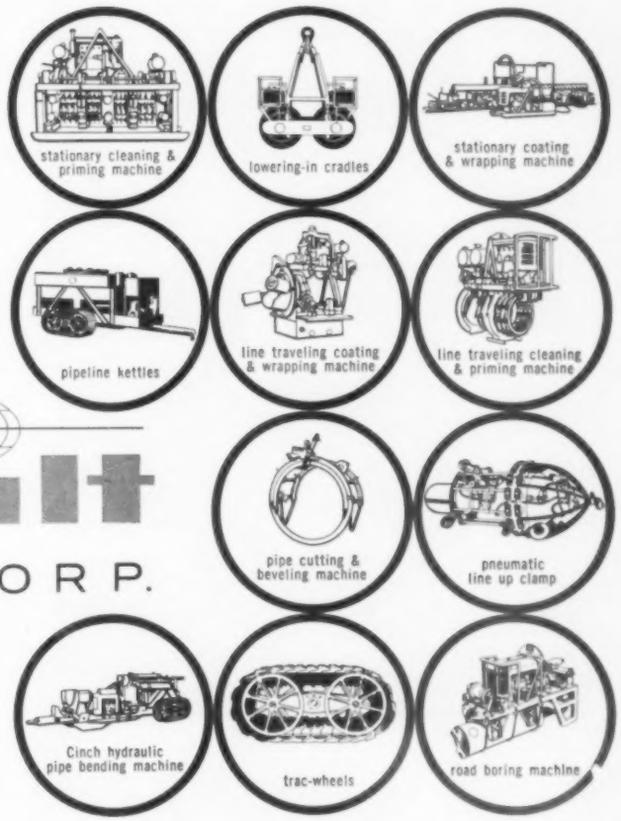
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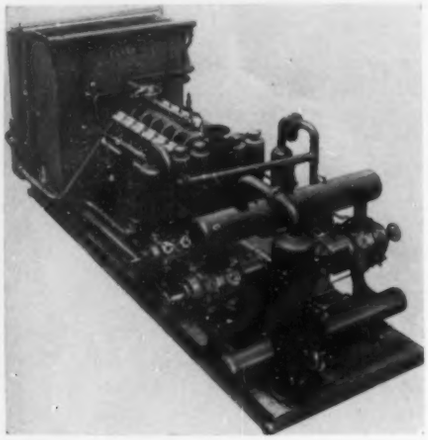
WILLIAM D. KOHLINS to vice president in charge of operations, Podbielniak, Inc., Division of Dresser Industries, Inc.

I. E. BOBERG, Chicago Bridge & Iron Co. engineering executive, has been elected to the firm's board.

C. J. FONTAINE and **B. A. (Beau) WENDT** to two new top ranking sales positions at Reed Roller Bit Co. Fontaine, divisional manager of Central American sales for the last 16 years, has been named domestic sales manager, and Wendt has been elevated to assistant to the vice president of sales.



New Packaged Field Compressor

Just introduced by Clark Bros. Co., division of Dresser Industries, Inc., new Model CFB-4 extends to 750 bhp the horsepower range of the Clark CFA-CFB Packaged Field Compressor line. Incorporating design and construction features that have been proved in more than two hundred such units, the compressor is designed for heavy duty applications where greater capacity and one to four stages of compression are required.

Built in sizes from 400 to 750 bhp, the CFB-4 uses a 5-inch stroke, four-cylinder, balanced/opposed compressor with extra heavy case and running gear to accommodate the higher loading. A completely self-contained compressor station, the unit can be used for gas lift, gas boosting, repressuring, pressure maintenance, field gas gathering, pipeline testing, and air drilling. Operating at 1,000 rpm, the compressor is directly connected to an oil field type engine by flexible type coupling. Belt and gear drives are eliminated.

Thirty-six standard cylinder sizes ranging from 21-inch diameter down to 2¼-inch cover a pressure range from vacuum to 6,000 psi. Both lined and unlined cylinders are available and can be mounted interchangeably in any combination. Cylinder bore gas passages and valve areas are fully water jacketed for maximum cylinder efficiency. Valves are precision cast of fine grained semi-steel.

CGG Has Air Geophysics Service

Cie Generale de Geophysique has extended its operations into airborne geophysics by retaining the key technicians and specialized equipment of the S.A.R.M., which recently terminated activity.

Already well experienced in aeromagnetic measurements and interpretation for petroleum surveys, C.G.G. is now undertaking similar work for mineral prospecting. Airborne radiometric methods are also employed.

Ohio Oil Has New Division

The Ohio Oil Co. has established a new chemical product development division and will substantially increase staff and facilities at its Denver Research Center to give greater emphasis to work in the petrochemicals field. W. H. Barlow, manager of research and planning, and a member of the board of directors since 1959, has been elected vice president. He will be in overall charge of the company's chemicals, planning and research organization. Dr. R. H. Reitsema, a senior planning associate, has been named manager of the newly created chemical product development division.

Petrolite Changes Announced

Dr. C. M. Blair, president of Petrolite Corp., St. Louis, Missouri, has announced the following position assignments: A. F. Wirtel, vice president of Petrolite, joins the staff of Wilbur C. Adams, general manager of Tretolite Co. division, as scientific and economic advisor. Dr. G. J. Samuelson, formerly director of research, becomes technical director and chief chemist for Tretolite. L. C. Widdoes, president of Internuclear Co. (Clayton, Missouri), a subsidiary of Petrolite, becomes director of research for Petrolite, and Carl F. Leyse, recently appointed general manager of Internuclear, becomes chief executive officer to succeed Widdoes.

Wischmeyer Appointed Vice President

Russell R. Wischmeyer has been appointed vice president in charge of construction of Pittsburgh Piping and Equipment Co. He will direct and coordinate the company's fabrication and installation of piping systems for electric utilities, paper mills, chemical process plants, etc. Wischmeyer was formerly associated, for 35 years, with Midwest Piping Co. As Midwest's construction vice president he supervised installation of many high pressure-high temperature piping systems.

Humble Converts Kentucky Stations

Humble Oil & Refining Co. has announced conversion of its existing service stations in Kentucky to the sale of Esso branded products. The company now will market its products under the Esso trademark in 23 states east of the Mississippi.

Service stations in Louisville will be the first to be affected by the changeover. Previously the Humble company's operations in Kentucky were conducted by service station managers selling under the Oklahoma brand name.

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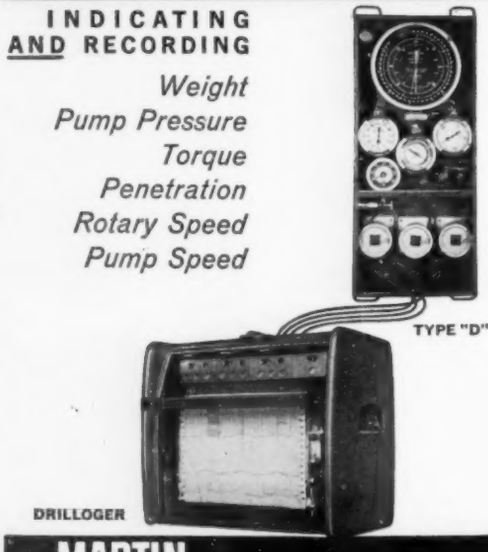

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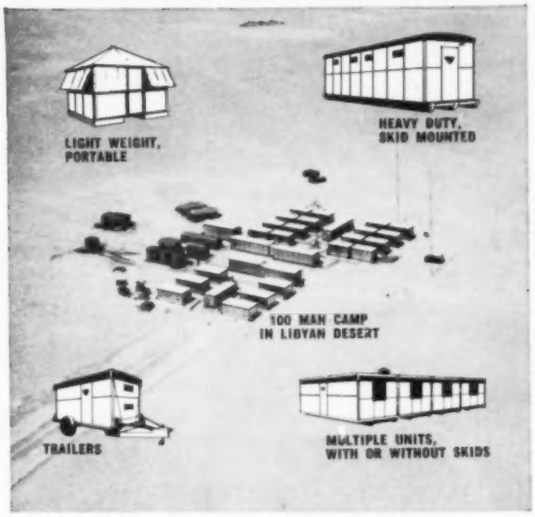
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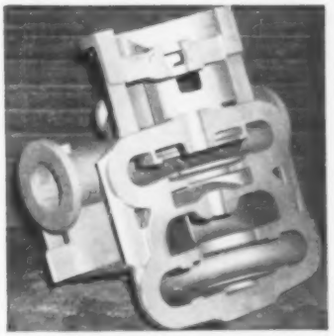

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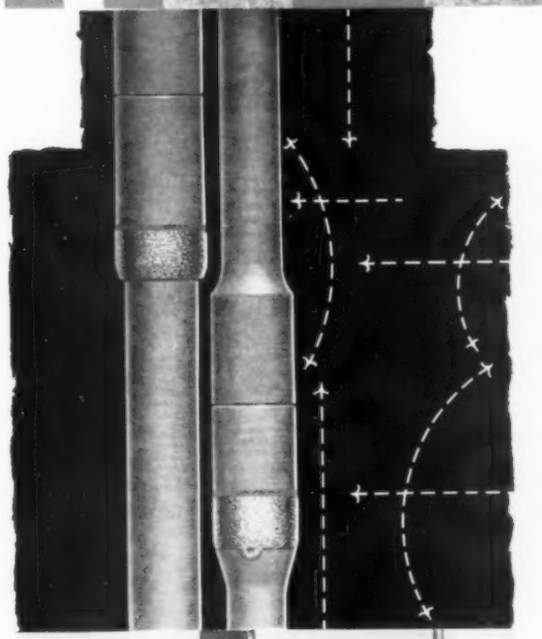

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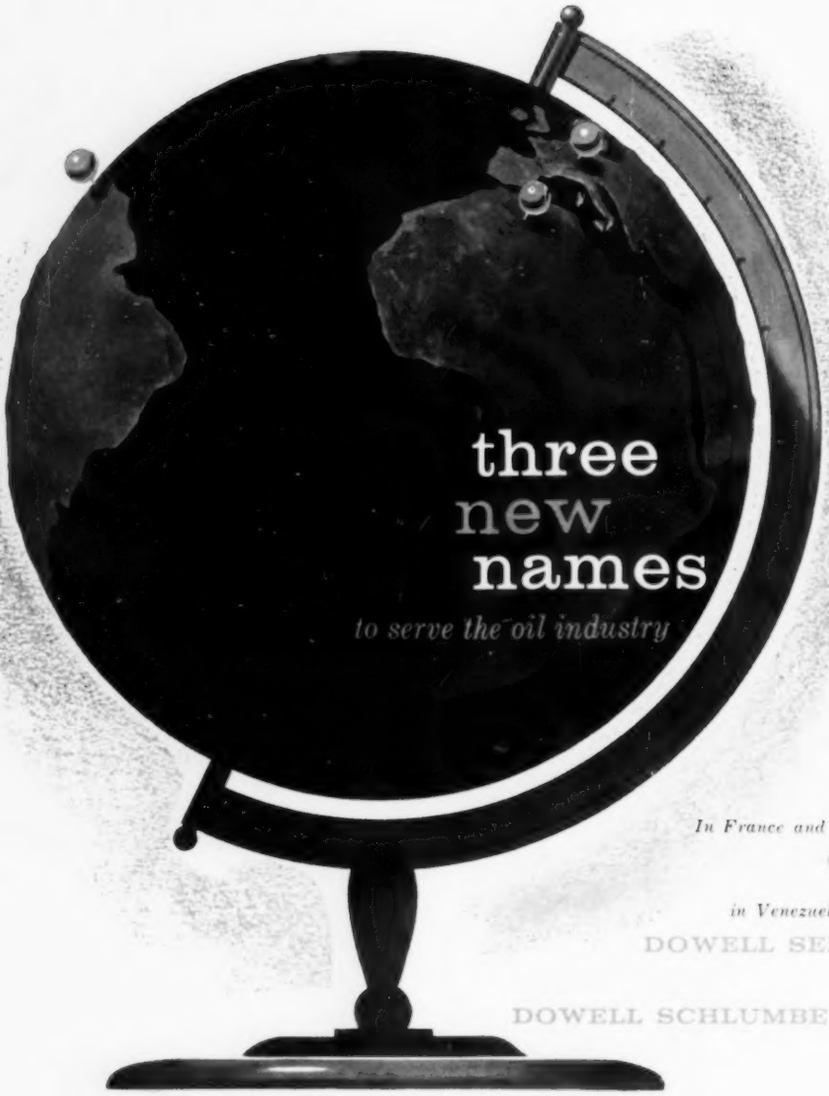

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